SANITATION
PRACTICALLY APPLIED

BY

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FIRST EDITION

NEW YORK
JOHN WILEY & SONS, Inc.
London: CHAPMAN & HALL, Limited
1917

Stanhope Press
F. H. GILSON COMPANY
BOSTON, U.S.A.

PREFACE

The practical application of the principles of hygiene entails more than a knowledge of theory. It requires detailed methods to determine what is needed in each particular community and how these ends may best be met. Since the ideal is not always attainable it is far better to accomplish some change in conditions than to rest on the unaccomplished demands for the superlative: to serve, at least, as an educational feature to show what efforts are needed. Practical suggestions, not theoretic requirements, are needed.

The practical consideration of public hygiene does not invite a discussion of the theories involved in the transmission of disease or in the biological processes through which natural forces operate. Means for the determination of biologic species, a classification of the specific characters and the various laboratory methods of examination and analysis are unnecessary in a book on the field practice of sanitation. The man working to improve sanitary conditions needs to know how to apply the practical measures which will yield results. A guidance for the selection of alternatives is desirable, but since conditions for living vary so greatly, it seems necessary to include minute details in certain instances to assist in the choice of methods to be adopted. This is especially true when considering the chief questions of sanitary engineering, as water supplies, wastes disposal, heating, lighting, and ventilation.

Sanitation is in its developmental stage, as are the other sciences, and new theories and newly accepted facts appear with frequency. This is no less marked in the control of disease than with other divisions of hygiene, and any statements now accepted may soon prove to be entirely

erroneous, and any methods now advanced for controlling diseases may later, upon the presentation of more evidence, be shown to be impractical, unjust or tangential.

This book is offered also as a corollary to the numerous excellent treatises on the theory of hygiene and the laboratory manuals, since the man in the field desires to know how sanitation of the home, of the school, of the factory and of the community can actually be obtained. It is intended primarily for the health officer and for the student of public health topics, but the employer, the employee, the teacher, the man in his own home or office, or the municipal official may get some practical directions from it.

The illustrations, all of which are original drawings and photographs made by the author, are introduced only as explanatory illustrations for the text, and not simply as pictures about the subjects.

Dec. 1916.

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Sanitation Practically Applied

CHAPTER I

THE NEED FOR PUBLIC HEALTH WORK

Public health is an indispensable asset for the progress of any nation and its attainment an object of the first magnitude. The more protection a people is offered the more rapidly is it able to advance in civilization, in learning and culture, and the misery and ravages from catastrophe and pestilence will be correspondingly less. It is true with the individual no less than with the masses. With public protection from disease and personal avoidance of infection the individual enjoys more health, is better able to withstand the strains and depression of illness and accident, and hence maintains more ability and desire, more vigor and vivacity. He is therefore more efficient in business, in commerce, and in the arts and sciences. As in the past, so in the future will those communities and nations prosper and advance in direct proportion to the care they give to the health of their people. No one is able to develop his resources to the fullest extent or to produce the best results from his undertakings when hampered with disease, or overcome with avoidable bodily defects. The greatest factor in efficiency is health. The greatest resources, alike for the community and for the individual, are life, health and strength — and the great principle of which these are the product is hygiene.

The Value of Human Life. — The value of human life becomes the basis for all large expenditures for public

health accomplishment. The ledger page of every health officer's account book should have a credit column of lives saved to balance the energy and money expended. This credit is most humanely phrased as diseases prevented and lives saved, but for public and legislative consideration it frequently becomes almost essential to place an arbitrary money valuation upon life. A man's value is measured by his ability and efficiency for work and by his usefulness to his family and to his country. These attributes are not measurable in dollars, for his worth varies according to the opportunities and to the needs of those dependent upon him. Nevertheless, for the sake of argument in elucidating a nation's needs, losses or gains, an arbitrary money valuation is placed upon human life. Formerly, writers selected estimates varying between $145 and $1500. It is usually now conceded that the average male citizen may be worth $2500. The fallacy of adopting any such standard valuation of life as a means of demonstrating work accomplished, or needed, is apparent. A community may be composed largely of poor people; the wage earners may command large salaries; the proportion of married couples may be large and the families may be large. All or any of these conditions may be the reverse, and yet these are but some of the factors which influence a man's worth. If it is desired to show what financial gain has been accomplished through a definite expenditure many local factors should be considered. To accept from another community a certain estimated figure as the average wage of the people involved is fallacious. To adopt a certain set figure as the value of a life, or as the length of time a man might have been ill, or as the expense of medical treatment he may have had, represents such variations from actual conditions as to be almost valueless. The financial loss sustained by a community through an epidemic can be determined, even approximately, only by learning the actual loss of wage and the actual expense of medical treatment of each individual.

It is more correct to make a careful financial survey of definite sections of a city, or of the consecutive families involved for a certain period, and estimating for the total community, than to declare each life to be worth $2500 and that each day of sickness causes a loss of $2.

The cost of an epidemic in any community can be determined quite closely, but not wholly in money valuation. The factors which make up the public and private loss are the number of lives lost and the financial cost. The lost lives and the expended money are distinct and individual, and under no system can they be added justly or accurately. It cannot be stated that a community loses a certain amount of money through typhoid fever. The proper statement would be that the community has lost so many lives and also has needlessly spent so much money because of the presence of typhoid. The value of lost life cannot be represented by a figure: $2500 is not the average value of a human life — nor is any other figure. When estimating the lost or expended money resulting from the presence of an outbreak of disease, various factors of expense should be included, and be fully determined for each involved individual or household. These constitute the loss of wage or income of each affected individual of each household; the commercial financial loss sustained by the establishments employing these individuals; the loss through diminished wages during the entire convalescence; the total expense of medical, hospital and nursing services, with the cost of medicine; the difference in the household expenses as varying from those of normal times; and the expense of distant trips taken to promote convalescence. Funeral expenses should not be included as they are actually only hastened and not preventable expenses. Since all the extra expense of an outbreak is only a means for increasing the circulation of money, the real loss sustained by a community through an outbreak of disease is the loss of life and the subjective discomforts and suffering of those

who are ill. The loss from disease, however, usually falls upon those families who are less able to withstand the money obligation.

Organization. — State health bodies may have their greatest effectiveness when organized as state departments of health, presided over by a commissioner. The various branches of work to receive attention are then formed as bureaus, and at the head of each is a director or chief. The bureaus may be enumerated as those of vital statistics, of communicable diseases, of engineering, of foods and drugs, of child hygiene, of industrial hygiene, of publicity and education, and of accounts and supplies. Aside from these bureaus is the organization of the state sanitary districts, under the direction of the assistant commissioner. The bureau of communicable diseases includes the divisions of laboratories and of epidemiology, as in Minnesota. The bureau of engineering comprises the architectural division and the water supply and sewage disposal work. The food and drug laboratory is established under that bureau. The bureau of child hygiene includes school inspection and infant mortality work. The bureau of industrial hygiene carries on those activities in factory inspection and hygiene which are not undertaken by the state factory inspection department, to include problems of housing and occupational diseases, but not industrial accidents.

City health departments may similarly be constituted.

Practically all sanitarians at the present time are officials in some government service, or occupy official positions in a commonwealth or municipality or upon the teaching staff of a college, and are hampered by official contracts or by work from engaging in outside commercial activity. Many state or city departments are doing much work of a public health nature, but they are limited by laws or resources from engaging in all the work which needs to be done. Conditions are rapidly shaping themselves so that there will be an increasing demand for consulting sanitarians.

These experts will commercialize alone and not be affiliated with any state or municipal government or with any institution. Conditions will soon be ripe for this new department in the practical application of the sciences. This new profession is not a departure from medicine but an advanced development in it, combining those sciences known as public health, state medicine, sanitary science and preventive medicine. The need of a concise and comprehensive name for this specialization is apparent, as the general public understands the term "sanitarian" to indicate one having only a knowledge of ventilation, cleanliness, pure water and the methods of disposal of wastes.

THE NEED OF WHOLE-TIME HEALTH OFFICERS

If a community entrusts its health, its questions of sanitation, the life of its school children, its control of transmissible disease, its industrial conditions and its uncertain food supplies to a busy medical practitioner, the public duties of such official can scarcely receive the attention they need. No time can be given for investigating, for following up contact cases, for searching for disease carriers or for carrying on any propaganda of reform, improvement or public instruction. The doctor who practices medicine, having devoted his time to the study of a particular phase of medicine, has not the education and training which make for efficiency in a health officer, and therefore he is not able to successfully pursue the essential measures of public health work.

Communities frequently appoint as health officers convenient laymen who know nothing about the subject in hand, the prevention of disease. Farmers, plumbers, real estate agents, ministers and store keepers, valuable and needed in their own particular spheres, scarcely have the necessary training to determine when a scarlet fever case ceases to be infectious, when a sewage treatment plant

is inefficient, how to manage a diphtheria carrier, how to practically improve local industrial hygiene, how to detect the local cause of infant mortality, or other similar questions which confront the true health officer. Yet to them frequently is entrusted the lives of the people. No community can afford to have its health and life engineered by any but an educated and trained man. More lives are placed in jeopardy by such mismanagement than would occur by placing in the locomotive cab a man who never saw a railroad. Vital statistics amply prove the damaging influence of the continuance of such folly. If the men who have appointed the majority of health officers had measured up to the importance of their responsibilities, the figures revealed by morbidity and vital statistics would have a vastly different appearance. The many difficulties attendant upon the employment of an untrained man or upon the brief services rendered by practicing physicians serving as health officers, can be obviated by the community securing the services of a trained medical health officer who will devote his entire time to the work.

Qualifications. — The chief qualification to consider in selecting a health officer for a small town or rural section is a medical training. The practical control of the infections and the elimination of disease are the foremost duties of a health officer. Since in small communities, small towns and rural districts, this entails on him an ability to diagnosticate communicable diseases, the health officer should be a man of medical training from a school of high standing. Many laymen can diagnose the distinct cases of the infectious diseases, but these are not the cases which give chief concern to the health officer. A person without sufficient medical and other special training would scarcely know how to discover and control the carriers of disease germs, or how to diagnosticate the border line cases which closely resemble different diseases. This work as well as the examination of supposedly healthy school chil-

dren requires a medical training. The local health officer should be qualified as a laboratory diagnostician.

In larger cities the duties may permit a civil engineer or a man of business training to serve as head of the health department. If the city is developing its water, sewerage or scavenger systems the duties may require the services of a civil engineer. But wherever the executive head of the health department is not a physician, the lay official should not assume abilities beyond his training, but should have an assistant who is a physician and by whom should be decided the questions of the diagnosis and control of reportable diseases, the work for district nurses, the questions of fumigation and school examinations, the collection and compilation of statistics, and the development of dairy hygiene. These are largely medical decisions. Special training, rather than medical training, is, however, essential for all these classes of health work. Most of our best statisticians are not medical graduates. They, however, are not required to perform autopsies or to diagnosticate diseases. A veterinarian does not necessarily become the best dairy inspector and neither does the general medical course develop health officers. A physician accepting the post as health officer should not assume knowledge beyond his training. Such questions as engineering problems, educational schemes, building construction problems, sewage treatment and water filtration should be submitted to those who are educated and trained in these particular lines. The business of the various lines of work pursued by health officers tends towards specialization, but men can be found or can be trained to be specialists in all lines. Such men, able to manage each individual bureau of the large department, become the most advantageous directors for the whole department. He who becomes director should be broad minded enough to consult with eminent professional men before making the appointments of his assistants.

The rural health officer must be a versatile man in his profession. A man without a special medical training cannot hope to attain efficiency as a rural health officer. His greatest work is in diagnosing diseases. Many people serving as health officers may be able to recognize typical chickenpox or a marked case of diphtheria or measles. These are not, however, the cases which confront the health officer. He needs must know how to diagnose a case of smallpox having but a half dozen vesicles, he must know how to find and control a diphtheria carrier and how to judge when measles ceases to be infectious. The rural health officer may be confronted with the problems of designing an effective sewage disposal plant, of locating a safe ground water stratum or of finding the source of a typhoid outbreak when a well has been wrongly suspected. The duties of a health officer are multitudinous and depend upon local conditions, local needs, local population and local appropriation. He should have absolute command of contagious cases. His should be the final diagnosis of reportable diseases. His opinions should not be dogmatic, nor given without due consideration of the ability of others.

The modern whole-time health officer is a health director rather than a community official. His title should be director of health, rather than superintendent of health, health officer or city physician. His work is much more than that of a public prosecutor, a detector of nuisances or a placarder of houses. His work is to decrease disease and to instruct others how to detect and avoid dangers. His duty is to teach the public first aid to itself. The improvement of industrial, social, scholastic and vital conditions is his work, with a view of eliminating those factors which increase suffering, discomfort and disease. The economic questions of life are of but minor importance and should not be considered by the health officer except indirectly and secondarily to the saving of lives.

Whether or not the supervision of garbage and ash col-

lection, street cleaning, night-soil removal, dead animal and manure removal, dust eradication, drainage and plumbing, and the elimination of city wells and yard toilets should be included in the duties of a health officer is apparently of local concern. These duties do not belong to a health officer, since they have only an indirect influence upon health. In so far as yard and barn nuisances permit the breeding of mosquitoes and flies, and as an excessive amount of street dust may slightly irritate the throat, and the production of noisome odors may indicate decomposition, these problems have some effect upon health. There are plenty of more direct problems for the health officer to consider. The aforesaid supervision should be placed in the hands of the bureau of highways, to which bureau the health office may submit reports of any nuisances encountered. In large cities where sufficient bureaus of the health department can be developed, some of these activities may be handled by the health department. In small towns there is usually enough work with the control of disease, and with the schools, the infants, and with the milk supplies and other numerous problems to engage the entire energy of the health officer and his staff.

The legal enactments under which a permanent health officer operates are more satisfactorily conducted when formulated as rules having the force of law, rather than as laws to be revised by slowly-acting bodies. With the rapid development of sanitary science frequent changes must be made in the methods of the health officer. The activities of the office should keep abreast of the times and adopt improvements as their correctness and usefulness become assured. Questions in the control of communicable diseases, the efficacy of disinfection, the problems of ventilation and of housing, and minor points in plumbing and garbage disposal are undergoing rapid changes. When a system or a practice becomes obsolete the health officer should be permitted to discontinue it. When he is required

by law to disinfect after measles, to maintain house-drain traps, to quarantine those who cannot transmit infection or to judge ventilation upon insufficient evidence, if he wants to discontinue such practices believing them obsolete and unreasonable, he is hampered by a legislative body of laymen who may not meet for many months or who may refuse to amend the law. When such questions can be settled by the decision of a health officer of recognized ability the chair he holds can keep abreast of the advancement of science. It is by such powers granted to a few men and through their abilities that the science of public health advances. If a man is not by law compelled to disinfect, he may with reason and by research determine the value of disinfection. By such work does science advance, as in the researches of Chapin upon the efficacy of house disinfection. Where a health office is of political design, with frequent changes of the health officer, and the men selected are practicing physicians, it is advisable to have legal control vested in laws, rather than in rules which may be altered to suit the personal whims of a temporary and inefficient man.

SANITARY DISTRICTS

The states should be divided into sanitary districts, each district to be presided over by a whole-time health supervisor under the appointment and control of the state department of health. The area of each jurisdiction is for the state's decision. The county lines may offer satisfactory limits in some instances, but not in others. In a town near the border of a county it would be absurd for the supervisor to have jurisdiction in the one county alone. The size and shape of the health districts will be determined by the location of railroads and other lines of travel or commerce; they should include with the cities the surrounding territory supplying the markets of these cities; they may be limited by mountains or obstructing rivers. The ease

or rapidity of travel for the district supervisor should be considered. The size of the territory or the population which can adequately be covered by a whole-time health officer would depend upon the means of transportation at his disposal more than upon any other factor. He should be so salaried that an automobile is available.

Appointments. — Appointments to positions as health officers of rural districts or small towns should be made by or under the advice or control of the state department of health. Selections of whole-time health officers should be made by the state department of health. If a state department of health has a right to appoint local registrars for collecting statistics, requiring the counties or municipalities to pay prescribed fees for the work, it seems reasonable to believe that this same centralized authority has a right to appoint whole-time health officers, to fix their duties, to limit their jurisdiction and to require the local community to pay given or fixed fees or salaries. The making of appointments by state departments of health would have a tendency to remove from consideration politics, favors, personalities and social obligations. The state has a right to demand the appointment of health officers who are made efficient by training, by legal powers and by sufficient remuneration. As the health of a community affects the state and as the presence of local disease endangers neighboring communities, the state department of health should have the authority to determine the rate of compensation for local health officers when the local community fixes the salary at such a low figure that no effective work can be accomplished. The danger arising from lack of uniformity of work by adjoining communities may be offset by state control.

When a small city or a county is unable adequately to provide for an efficient whole-time health officer, it should cooperate with adjoining towns or counties that their combined strength may employ a man who will be constantly

watching and working to preserve the public health. When entertaining such an agreement the union of the towns or counties should be sanctioned by the state department of health, which is best able to judge of the advisability of such a combination.

Cooperation by the Public. — The protection of life is a cooperative duty the requirements and responsibilities of which devolve upon each citizen. The laxity of the public observance of this duty is due to the lack of attention given by the health officer to the proper education of the public. As an obligation of citizenship, the public should assist the authorities to enforce the laws that life may be protected. People save others from accident whenever possible, but knowingly, carelessly or thoughtlessly permit their children or their neighbors to be exposed to contagious diseases. Many persons frequently have the opportunity to assist in the control of infectious disease, thereby preventing sickness and death from measles, whooping cough, smallpox, diphtheria and scarlet fever. Those persons who see a case of infectious disease appearing in public should use their influence to have the contagious case removed and isolated from public exposure. The ignorant and thoughtless parents or caretakers of the contagious cases should be told of the dangers of exposure and how to avoid them. Each person who, while having an infectious disease, knowingly exposes himself to others, breaks the law and should realize that he is liable to prosecution. He should be apprehended and controlled. The people should use their personal influence with the guardians of the children who have contagious diseases, and with the patients themselves. The public should assist the local health officer in locating these cases of transmissible disease. As the public notifies the police authorities of the presence of dangerous characters, so should they notify the health officer of the presence of dangerous disease transmitters. There are many people who are carriers and transmitters

of disease, who are not seen by physicians and thereby are unknown to the health authorities. Their presence is frequently known to neighbors and others, and by them should be reported to the local health officer. The larger an outbreak of disease the greater is the proportion of missed cases, and these unseen and unreported cases are the most dangerous. Their location is most desired, that the outbreak may be controlled. These missed cases may constitute over 75 per cent of the cases of an outbreak, and yet many of them are known to the general public. By making prompt reports of the names and addresses of all known or suspected cases of communicable diseases the public can be of great aid to the health officer.

WORK FOR HEALTH OFFICERS

The goal of all health work is the prevention of disease and the saving of lives. The particular methods to pursue in each community are determined locally from a study of the conditions as revealed by local vital statistics and by surveys of various characters. The conditions vary widely in different localities, varying with season, with latitude and with the previous development in public health. The diseases to be met differ geographically, as do the industries and social conditions. Health activities should be instituted where needed and when needed. They should be timely, their need should be anticipated and their development begun when most effective.

A monthly program is desirable for outlining the seasonal work for health officers of counties or towns. When adopted, such a schedule serves as a stimulus. It indicates the essential activities which should be considered by any health department, and becomes the working basis of regular, systematic public health work. It serves as a check list for anticipating needed activities. A monthly program is recommended because it is timely, seasonal and practical. It is the essence of system.

Annual reports should be compiled in January, when needed, and not left until September. If semi-annual clean-ups are made they should be at intervals of six months, during April and October. Fly and mosquito campaigns should be begun at the first appearance of the insects, rather than late in summer. Baby week campaigns should be held in early June, when active work is needed to help the babies for the summer. When school commences in the fall the children should be inspected for contagious diseases. No time during this month should be given over to making examinations for physical defects of children, but the time should be used for checking the spread of school diseases in their incipiency. If physical examinations were made at this time, there would not be sufficient time to make the daily inspections for contagious diseases. The children may be examined for physical defects during the winter months when fall health activities have passed. Privy vaults are of greatest concern during fly-time. Inspections to enforce the cleaning of vaults should begin before the flies become active, in April in temperate climates. In the winter and early spring school examinations and the control of contagious disease will occupy most of the time of the health officer in a small community. The work begun upon any subject during any month may be continued into the following months. Epidemiological work upon any disease outbreak should be done when the disease appears, irrespective of season.

These brief explanations will indicate why I have arranged the monthly program as herewith presented. The succeeding chapters of this book show how these various lines of public health work may be performed in a practical way.

Geographically activities vary. Inspections of various industries as canning factories, oyster beds, cheese factories, and the many plants inspected for industrial hazards and occupational diseases are dependent upon geographical

locations. It is impossible to make a schedule to be universally applicable. One district will have trachoma, another hookworm disease and another industrial tuberculosis. The accompanying monthly program was arranged specifically for West Virginia, but may have usefulness in other localities without much alteration.

MONTHLY PROGRAM FOR HEALTH OFFICERS

January —
- Compile and publish annual report.
- Make physical examinations of school children.

February —
- Track up disease contacts.
- Plan and execute educational campaign.

March —
- Control diseases. Examine school children.

April —
- Institute semi-annual clean-up.
- Clean privy vaults.
- Begin dairy farm inspection.
- Begin movement to improve sewage and garbage disposal methods.
- Institute fly campaign; destroy breeding places, order manure boxes.

May —
- Inspect alleys and lots, garbage and rubbish piles.
- Investigate sources of water supplies.
- Inspect rural schools for sanitation.
- Inspect creameries, cheese factories, slaughter houses.
- Follow up discharged tuberculosis cases.
- Investigate summer resorts for sanitation and disease carriers.

June —
- Hold Baby Week; establish baby clinics.
- Get visiting nurse for infant welfare work.
- Begin mosquito campaign.
- Attend annual conference of state health officers.

July —
- Make rural investigations of typhoid, hookworm disease, trachoma.
- Inspect summer resorts in operation, picnic grounds and camps.
- Inspect sanitation of transportation companies.

August —
- Prepare health exhibit for fairs, schools, etc. Continue inspections.

September —
- Hold health exhibits at county fairs.
- Collect data on sanitary improvements made at schools, etc.
- Inspect canning factories.
- Inspect school children for contagious diseases.

October —
- Begin examination of school children for physical defects.
- Institute rigid control over every case of contagious disease.
- Track up disease contacts, instruct and control them.
- Institute semi-annual clean-up.
- Attend meeting of the American Public Health Association.

November —
- Hold public health meeting in county medical society.
- Investigate water purification and sewage treatment plants.
- Follow up discharged tuberculosis cases.
- Develop factory hygiene.

December —
- Investigate jails, asylums, public buildings and theatres.
- Check up vital statistics records, births and deaths.

THE CONTROL OF HEALTH RESORTS

A sanatorium is a place where people go to acquire health, a sanitarium is strictly an institution for maintaining health.[1] The former is a hospital, the latter a hotel. A sanatorium is intended for the sick but the patrons of a sanitarium are supposed to be healthy vacationists. The two names are frequently incorrectly used synonymously to indicate a hospital, a medical institute or a home. Since convalescent cases and those who are actual disease carriers frequently patronize hotels and resorts intended for the healthy, and since healthy people visit resorts hoping to remain in health, an effective supervision over the resorts where people congregate in large numbers should be maintained. This should be a state supervision extended by a state department of health and should include all resorts, all hotels used by summer or winter visitors or

[1] An etymological distinction recognized by Stormonth, Gould, Encylopedia Britannica, Century and Standard Dictionaries.

vacationists, pleasure and recreation resorts, parks, chautauquas and encampments, camp meetings and excursion places, the so-called watering places, bathing and shore resorts, the so-called medicinal spring resorts, and localities or institutions advertised as sanitaria and sanatoria. All these places are patronized by the public in large numbers and all are apt to become foci for the distribution of infectious diseases. State appropriations for the inspection, cleaning up and control of these places would be money well spent. The inspections of the summer resorts in New York, begun by the State Department of Health in 1896, attest the value of this work. The great mass of typhoid infections which originate at the summer resorts is further proof of the need.

Mineral spring resorts, according to their advertisements and practices, prescribe for and treat the sick. They are institutions, therefore, practicing medicine, and should be placed under the same necessary control and given an analogous licensure as are individuals who practice medicine. This means that state inspections are necessary, that a certain hygienic standard should be maintained and that the resorts be in charge of competent licensed physicians who examine all persons coming for the baths or water. Many resorts are not under proper medical supervision. A committee of competent and accepted authorities should be delegated by the state to determine the status of all mineral spring resorts, and to determine the medicinal value of their treatments and of the vended waters, and to pass upon the reliability and correctness of all the advertisements and resort literature. This work is a need of the state, for people stake their lives upon the assertions and claims made by the commercial proprietors. People go to these resorts without consulting physicians for an opinion as to their personal condition, and without obtaining information as to the safety of the resort. A physician rarely has the opportunity to form an opinion about a

resort except by the advertisements he receives. Through its jeopardizing effect, the misbranding of resorts becomes a crime. It becomes a state's duty to protect her citizens against the careless management, the wilful deception and the intentional misbranding of resorts.

Public baths, bathing beaches and commercial bath houses should be placed under the supervision of the local health office. Bathing should not be permitted in sewage-polluted water; but proper and safe facilities are due the poor. Public wash-houses where the poor may clean their wearing apparel, which is then dried by steam pipes while the owner is taking a shower bath, should be provided. Public bath-houses should be arranged so the bather will be compelled to pass under a shower, wading through water, before he may reach the pool. The bath tubs of penitentiaries, jails, asylums, hospitals and charitable institutions should be replaced by shower baths. In hospitals the shower baths should be so arranged that the lower half of the needles may be used alone, the patient sitting on a provided seat. The valves should be so placed that the temperature of the water may be regulated without the person getting wet while turning on the water. A thermometer should be so enclosed in the large supply pipe that it may readily be seen and the correct temperature of the mixed waters be obtained before the patient gets wet. The holes of the spray pipes should be large and numerous in the hospital showers, that the sharp needling effect may be minimized. For certain cases of illness bath tubs are, of course, necessary as therapeutic agents.

The water of public bathing pools should be examined bacteriologically when deemed necessary by the local health officer. When sterilization is advisable it may be done by chlorination. Those in charge of bathing pools should be instructed in the methods of detecting and diagnosing cases of infectious diseases and should be required to exclude from the pool persons with infectious diseases. Some bath-

ing beaches and also floating baths subject the bathers to immersion in sewage water. Such bathing is absolutely dangerous to health and should be prevented. State and municipal authorities should post warning notices near dangerous places. Bathing in rivers and lakes receiving sewage near-by should be prohibited. Popular camping grounds and similar places in the country where large numbers of people assemble should be well posted by state authorities with warning notices of dangerous water supplies and bathing beaches. Safe public baths should be provided within the cities.

THE SANITARY NEEDS OF INDUSTRY

Industrial establishments are compensated by active public health work to the same extent that communities may be benefited. Where sanitary supervision and medical inspection have been established in industries they have proved their worth and have proved that they are an actual aid to commercialism. Attention to industrial hygiene increases efficiency and hence output; it decreases illness and therefore increases regularity of working hours; it decreases industrial accidents, thereby maintaining a more regular and constant working force; it decreases doctor bills and maintains a more steady wage for the employees, decreasing the need for demanding increased wages; it increases the comfort and therefore the respect of the employees; it raises the moral tone of the working force, resulting in their employment being more appreciated, and makes the obtaining of jobs with the particular company more desirable. It helps to offset strikes. When employment with a certain company becomes especially desirable and the demands for jobs are many, the employers have a greater force of eligible men from which to select the more skilful and competent hands. The company can thereby fill all positions with men who earn much more than their salaries. Skilled workmen appreciate attention given their

health and their lives, and hence the better men seek those companies which are known to protect their employees. In working with industries sanitarians become, therefore, efficiency experts. The need for such men is limitless. The present demand is little because of the sanitarian being unable to guarantee immediate financial gain for the employer.

Successful employers do not place their employees upon a uniform wage scale for each particular kind of work, but grade each employee according to his efficiency and his worth. A man's worth depends upon his intelligence, his steadfastness and his ability to produce; upon the interest he exerts for the welfare of the company for which he works, upon his quick judgment and his attention to practical details. The amount of his wage should depend upon these factors and upon the size of his family. If the employer notes that one man's efficiency is not on a par with that of another doing the same work, he should seek the cause, as the decrease in efficiency may be due to some correctable condition. Each condition under which the men work should be investigated, as many causes of inefficiency are remediable.

The working conditions or factory influences which prevent a man doing the work he is capable of doing include the lighting facilities, the ventilation, the abundance of dust, the presence of noxious odors, gases or dust particles, overcrowding, dampness, noise, vibration of the building, the length of the dinner hour, posture, home life, housing conditions and many minor points. Many men are slow, old, careless, or otherwise naturally inefficient, and can be improved but little. The single greatest factor influencing a man's industrial efficiency is his health. The condition of a man's health, the effect of his work upon it, and the successful means which may be adopted for improving conditions need attention from the man himself, from his union and from his employer. Each of these three classes should

be shown how they can work for their mutual and personal benefit.

Workmen should have regular and periodic examinations made by their physicians to detect any physical conditions which need attention. They should have good dentists inspect their teeth semiannually. Any corrections needed should be made immediately. Any disease can be treated much more successfully and cheaply if given attention in the beginning than after a delay is permitted. This is true whether the diseased condition be tuberculosis or rheumatism, typhoid or malaria, a sore finger or a diseased tooth, defective eyesight or a sprain, or any other abnormal condition which may afflict the worker. The public should be taught to realize this. The workman should learn the eccentricities of the machine with which he works. He should learn how accidents may occur and how to avoid them. He should appreciate that rules of safety are formulated for his protection and the strict observation of them may save his own life. The workman should be taught first aid methods; how to apply bandages, how to find bleeding points and how to check hemorrhage by pressure, how to immobilize a broken limb by using a piece of wood as a splint, how to help a sprain by the immediate application of hot water, how to care for the eyes, and how, by artificial respiration, to resuscitate the drowned, the electrically shocked or those overcome by poisonous gases. This educational work may be undertaken in the factories by the health officer, or by physicians appointed by the companies.

THE LIMITATIONS OF A LABORATORY

Laboratory medical examinations are made to assist in establishing a diagnosis and to detect communicable infectiousness. In each instance the laboratory is of marked value, yet it also has more or less definite limitations. Those examinations for diagnosis which pertain to public

health should be made gratuitously by municipal or state laboratories. These include examinations for tuberculosis, typhoid fever, paratyphoid, malaria, diphtheria, intestinal parasites, various forms of meningitis, ophthalmia neonatorum, anthrax, cancer and parasitic meat infestations; and they include water and sewage tests and analysis, examinations of oysters and milk. From the standpoint of public health these examinations are not made for the purpose of diagnosis, but to determine infectiousness, except with cancer, and are made for the purpose of establishing quarantine. The public examinations should not include examinations of tissues, except those of supposed cancer. Such routine examinations as urinalysis, ordinary tissues, blood counts, and gastric analysis concern none but the individual, and therefore, not being of public health import, do not belong in a public laboratory for free service. Since laboratory examinations for syphilis and gonococcal infection are not made to determine quarantine, the writer holds that these are not the work for the public health laboratory, but should be placed in the hands of experienced private laboratory workers.

In examining some cases of infectious diseases it occasionally is necessary to make many repeated examinations before the infective organisms are found. The chief significance of this is that the patient, not passing many of the bacteria, is not a great danger as a transmitter of the disease. When great numbers of the infecting organisms are readily found, the person from whom the specimen was obtained is a dangerous transmitter of the disease, and although his symptoms may be slight and his personal infection light, especial care must be taken against the disease being spread to others. When few germs are being voided, the public danger being correspondingly less, less exacting care need be taken in preventing infection, allowance being made for the variability in discharge. All laboratory reports which are sent to the attending physi-

cians should make a note of the relative prevalence of the pathogenic germs, especially when these are found in great numbers, stating that the patient is a special danger, and great care should be exercised to prevent transmission of the disease.

Laboratories under competent directors should be established and used that early diagnosis may be made and further transmission of the infections be prevented. A laboratory examination is frequently essential in the diagnostication of the obscure and borderline cases. The value of correct and early diagnosis is evident. A definite diagnosis cannot always be made from a single laboratory examination. Particularly is this the case with tuberculosis. When pulmonary tuberculosis may be present and one sputum examination does not reveal the presence of tubercle bacilli, repeated examinations are indicated. Physicians are too prone to accept a negative report from the laboratory as proof of the absence of the disease. No bacteriologist intends to convey that impression. Laboratory reports are to be regarded as symptoms or signs rather than as the final proof. Pathogenic bacteria escape from infectious processes intermittently and not continuously; as a result, the organisms of typhoid fever, tuberculosis, diphtheria, gonococcal infection and perhaps other diseases cannot always be detected in the examined materials coming from the persons infected with these diseases.

The entire significance of the positive finding of the organism or reactions sought has not been definitely determined for every disease. The germs of disease are frequently passed by persons who do not have symptoms or effects of the disease, and who are not even dangerous transmitters of virulent bacteria. The finding of tubercle bacilli, diphtheria bacilli and other pathogens does not constitute making a diagnosis of disease, or necessarily of discovering carriers. When the disease germs are found in apparently healthy individuals, it is advisable to determine

the pathogenicity of the bacteria, for certain diseases, as diphtheria or tuberculosis. If the bacteria are not virulent and dangerous, the host should not be regarded nor treated as a carrier and transmitter of disease.

Laboratory technique which does not follow the latest advances, using differential stains for organisms like gonococci, and adopting measures of scientific accuracy, produces examinations of doubtful value.

CHAPTER II

STATISTICS

Statistics is the science of expression by classified figures of the correlated facts of sociology. It is a display of the numerical activity of dependence, showing graphically the counterbalancing of cause and effect, indicating needed action and proving the results of effort. Vital statistics measure the development and decay of a people, and reveal those influences which affect the life and the social conditions of the population. The collection of vital statistics indicates what needs to be done, where assistance is needed, the methods for work and what has been accomplished with the effort expended. A health office which labors in one precinct without learning that in the adjoining neighborhood there is much greater demand for service is working blindly and disadvantageously. Vital statistics will establish a claim for salubrity or will reveal the presence of dangers — both points of importance for every community. If a locality is especially healthful, the outside world should hear of it; if a community is beset with dangerous, unsanitary conditions or damaged by diseases, the local authorities should know it, that improvements may follow.

Vital statistics are the statistics of life; morbidity statistics are those of sickness; and mortality statistics those relating to death. Demography is the science of statistics in general as relating to the race, occupation and habitation of man, combined with the influencing factors of disease and the social status.

There are certain standard health statistics which should be recorded for all communities. These are the statistics of the social phenomena — the birth, marriage, sickness

and death of each member of the human family. With them should be linked the associated demographic distinctions of age, sex and conjugal condition, and other definite data for purposes of identification. All states should adopt the so-called Model Law for the collection of vital statistics, the newer Model Law for the collection of morbidity statistics and also the United States Standard Certificates of Birth and of Death.

The collection of statistics of births, deaths and disease should be complete for each community and state. Other vital conditions for which better and more complete statistics are needed are those relating to poverty and defectiveness, statistics of the insane, the feeble-minded, the mentally defective, and of dependents — collected with a view of discovering or explaining causative factors or influencing conditions. Complete statistics of the causes of infant mortality — including the factors of housing conditions, of heat, of inferior and improper foods, of parental ignorance, of flies, of poverty — are needed. Statistics collected to show the influence of certain streets or sections of foreign populations, of industrial conditions, of working mothers, of housing conditions, of proximity to dispensaries, hospitals or doctors will all indicate paths for improvement. Of whatever sort, statistics should be collected in a practical way, without bias, with uniformity, and with a consideration of influencing factors but omitting unnecessary detail.

Accurate Record Blanks. — Data blanks for collecting various statistics not only should be uniform in substance and detail with those used in other cities and states, but should be specific and exact in themselves. They should be so arranged that the schedule will supply the greatest amount of needed information, with the least demand upon the intelligence or memory of the person interrogated and without an opportunity for variation in the methods of recording. No ambiguity should be permitted to confuse the recorder. The records should be so phrased, recorded

and classified that anyone may later compile them without difficulty and without error. Full definition should accompany the use of all symbols, the adoption of which frequently simplifies the manner of making records. Whether the statistics are collected by trained inspectors or are furnished by the general public, they should be recorded upon printed blanks asking questions whose meaning is unmistakable. Definiteness is essential. As an example: A data blank should not inquire if a well is near to a drain or privy, but how many feet distant, also, if down hill from the polluting point and the kind of subsoil present, as loam, sand, gravel, boulders, or solid rock. A typhoid data blank should not ask if the stools of the patient were disinfected, but how both the urine and stools were disinfected and what was the final disposition of them, into sewer, cesspool, tub privy, open privy, privy vault, stream, buried or thrown upon the ground surface. Valuable data may be collected by supplying printed postal cards to physicians or to teachers or other laymen, provided the questions are exact and complete. If the information collected is not definite and full it is not reliable but useless, and a wasted effort. People should not be asked to contribute information which proves useless.

Score cards form an efficient method of recording statistical evidence in the field for the purpose of establishing comparisons and noting changes and improvements. They are especially useful when applied to inspections made to determine sanitary conditions and hygienic influences of such industries as are competitive. First introduced by Woodward for dairy farm inspections, their application has been extended to include all buildings inspected, factories, schools, hotels, farms, and all establishments where foods are made, produced or handled, and places of various kinds where people congregate or work. Their application is, however, limited. But with score cards, as with all statistical data blanks, the requirements for recording the

information should be specific and definite. The data obtained cannot be definite if the questions permit the usage of such general terms as " good " or " bad," or, if in giving a numerical score too distant limits are provided with the expectation that the answer may be distributed anywhere between them. In scoring the construction of a dairy flooring the blank should not use the elastic phrase, " flooring — 20 to 40," but should be specific to avoid the varying opinions of different inspectors. The card should, for the sake of uniformity, justice and comparison, state, as an example, " flooring: mud 0, dry dirt 5, poor boards 10, cobble 15, tight boards 20, concrete 40," or a similar notation. No leeway should be given to the whims, caprices or judgment of the recorders. An inspector may change his opinions or ideas from one inspection to the next, or may forget his previous grading, and hence at subsequent examinations would give different relative values to conditions which remain constant. His two records therefore would not be comparable, nor could his records be compared with those of another inspector. Elastic data blanks cannot be tabulated nor their records be reported with any degree of justice or accuracy.

The necessity of correct tabulations of statistics is obvious, as is the preservation of the records upon a uniform basis for comparison. Before drawing conclusions through comparison, it is wise to know that the comparison is justifiable and that the difference in ratios is not due to some circumstance or factor not hitherto considered. Only objects of the same class can be averaged, and only comparable figures compared.

Many municipal health reports are so inaccurate statistically as to be entirely misleading. The errors are entirely unintentional and can scarcely be overcome unless larger appropriations are given for their correction. Two competing cities may report their general death rates, one much higher than the other. The city with the higher

death rate may actually be the more sanitary city but the annual report fails to state that all still-births are included in the general rate, or that there is a high birth rate, that large hospitals are established within the city limits or that the occupations are especially hazardous industries; all of which factors increase the death rate. All of these great influences which affect health, as also the number of the foreign born when they become a factor in the general death rate, should be noted in the reports. For comparison, death rates should be weighted to provide for the greater influencing factors which vary with different cities. For cities of over 100,000 population the calculations would be too intricate and the factors too multitudinous to justify the labor, but they should give separate records of the hospital deaths and the imported cases.

For the sake of statistical comparison, state and municipal reports should have their fiscal year to coincide with the calendar year.

A common mistake is the manner of handling certain large numbers. In computing averages and making estimations therefrom, in estimating populations, in making bacterial counts and in using in various ways a small counted number which must be raised to a high power or must be multiplied by a large factor, the error is frequently made of continuing the use of supposedly definite figures when they should be replaced by ciphers. In estimating large numbers there is a source of plus or minus error which from the nature of the calculation is apt to occur. This error should be minimized or overcome by replacing all figures after the first two figures which follow the principal number by ciphers. As an example: 5,864,328 should be recorded as 5,860,000; 986,226 recorded as 986,000; 4862 as 4860.

The use of decimals is often misleading. Frequently they are a necessity, but a carrying of the calculation too far into decimals is to be avoided. Death rates carried

beyond the first decimal are misleading, wearisome and probably inaccurate and usually should be avoided. The system of the federal Bureau of Vital Statistics should be followed — the use of one decimal in reporting general rates. When statistical data are read aloud to an audience the decimals should always be omitted, as, when making comparisons, the decimal figures psychologically linger in the mind of the hearers, who thereby unavoidably miss the important figures.

BIRTH REGISTRATION

Birth registration is a necessity for the individual to obtain legal standing, and for the community to learn its degree of sanitary civilization and social advancement, that greater efforts and practical work may be expended to develop a better and more useful citizenship.

The United States Standard Certificate of Birth should be universally adopted for the recording of births.

Birth rates are calculated as the number of births occurring to each 1000 of population:

$$\frac{\text{number of births} \times 1000}{\text{population}} = \text{birth rate.}$$

The registration of births is legally recognized as a social necessity. Complete birth records are essential for efficient health work. Before complete records can be obtained, the practicing physicians and the general public must realize the importance of officially recording the births of all children. Every child has a right to be born alive, and the next inalienable right of the child is the right to be recognized as being alive and the right to receive his inheritance and citizenship. These rights become manifest upon the birth certificate. The original birth certificate signed by the attending physician or midwife, or a certified correct copy of it, is accepted in any court as prima facie evidence of the statements contained therein. It may be necessary

to produce legal proof of such data as are recorded on the birth certificates. If the proof is demanded, and the birth certificate be not forthcoming, it may be impossible to establish the essential facts.

The regularly registered birth certificate at once becomes legal proof of parentage, of inheritance and of citizenship. It may be accepted as proof of legitimacy, if such were the case. It may serve as legal evidence that a certain man, divorced or separated from his wife, was the beneficiary's father, and hence this child is entitled to the estate. A birth certificate is necessary to prove inheritance in claim for foreign estates; frequently to claim pensions; to prove citizenship to come into a country. Business contracts, personal liability and life insurance claims depend very largely upon indisputable legal proof of inheritance of the plaintiff as well as of death of the testator. A birth certificate is proof of age, evidence which is frequently necessary in order to obtain admission to schools, colleges, homes or asylums, or for enrollment in the military or Public Health Service. Child labor laws are very properly being made more stringent in demanding proof of age of young people seeking employment. Many are constantly refused the right to work and earn a livelihood because they are unable to produce satisfactory proof of age. The Philadelphia bureau of vital statistics received daily (1914) about forty demands for copies of birth certificates, but a very large proportion of the requests could not be granted because the births had not been recorded.

Certain fallacies and errors which are apt to occur upon birth certificates include the recording of incorrect names, owing to the subsequent adoption of a different name than that given at the first impulse; the omission of names, which renders cataloguing difficult; the intentional or ignorant evasion of the information relative to legitimacy; the incorrect statements made through lack of memory of the parents or of the physician writing at home; incorrect

statements made from the inability to understand a foreign tongue, and the variable ways for spelling many proper names — a distressing occurrence for cataloguing. Health officers, realizing the occurrence of the deficiencies of birth registration, should attempt to minimize them. A more complete registration of illegitimate births and of still-births is desirable.

Lost or omitted birth records occur from many preventable causes. These reports may be almost completely recovered by an efficient health officer. The individual physicians need checking. Incomplete certificates should be filled out. Parents cannot be depended upon to mail the certificates, except by continuous prodding by the physician. Doctors are apt to fail to record the births when called as a consultant or when attending the family of a physician. Births occurring without the attendance of a legalized doctor or a registered midwife are rarely recorded. Isolated rural births are especially apt to be missed. The occurrence of such instances can be learned by obtaining information through various channels, as from ministers, school-teachers, women prominent in their spheres, and by following up the individual rumors. In cities some missed birth reports can be obtained by a monthly or weekly interrogation of the police officers at their stations.

The work of obtaining birth certificates is purely the duty of the local registrars and local health officers. The neglect of this duty is good cause for disregarding politics and friendships when making the appointment of the incumbents of the health offices.

Methods of Checking Birth Reports. — By obtaining such data as names, birthdays and birth place from school children, obtaining information both of the children and of their younger brothers and sisters, a back checking of the birth certificates will furnish added records and will reveal which doctors and midwives are remiss in their duties

of registration. Through children in schools and through data obtainable while making house visits for other causes, information may be had of births not attended by either physicians or licensed midwives. This is especially true in rural districts, where birth registration is most apt to be incomplete.

The checking up of birth records exposes the efficiency of the local registration bureau. The most exact method but the most expensive is a house to house canvass. In cities making a police census the data are available when the census enumerates the babies under one year, giving the place of birth. Individual work for checking up births may be done by consulting baptismal and other church records, hospital records, by obtaining from school children names and birth dates of their younger brothers or sisters, by collecting data in houses visited for any purpose, and by questioning people in various walks of life. The checking up of death certificates and still-births reported as deaths will assist in discovering which physicians are dilatory in their reporting of births. It is also advisable to keep an alphabetical list of the local physicians for recording monthly the number of births they report. A physician's obstetrical practice will not show considerable variation from year to year, but may show the almost symmetrical monthly fluctuations occurring in the general birth rate of the community. If a certain physician's birth returns show a great decline from his usual ratio, or if no certificates are received from a physician who is not known to be a specialist in branches excluding obstetrical practice, the doctor should be interviewed by mail or telephone for an explanation of the discrepancy, with a request for complete returns. Checking up of the doctors' returns is not done for purposes of prosecution but as a further means of obtaining complete birth registration.

In rural districts with scattered populations the births and deaths appear few, and the book-keeping activities of the

local registrar frequently indicate carelessness and laxity of interest in official matters. The reports and certificates in such localities are frequently misplaced and lost, resulting in statistical inaccuracy, in personal hardship to those who later need the registration, and in misleading statements to the state officials. Such carelessness upon the part of local registrars should be discovered by cross checking and by a comparison of neighboring communities. If one district shows marked variations from adjacent districts an investigation of the cause is needed, and if necessary a search made by a state authority for suspected records, certificates or cases. With a system of county health officers under the control of the central state authority this work is accomplished, and the records kept accurate.

The registration of births is notoriously incomplete in this country. Every child should be registered, every child has a right to be registered, and, considering the increasing industrial, scholastic, municipal and governmental demands for copies of birth certificates, it seems likely that every child will some day need and demand a copy of its birth certificate. States and cities admit the woful incompleteness of their birth registration, yet some few make little effort to improve conditions.

Still-births. — All still-births of any age of uterogestation should be reported and the age recorded. When deemed inadvisable to require the reporting of early miscarriages, the law should provide for the inability some parents, midwives or physicians have in determining the exact age of the fœtus in months, by including a clause giving the length of the fœtus in inches, as well as a definite age, over which dimension all still-births shall be recorded.

Still-births should be reported as births, and also as deaths, the word "still-birth" or "still-born" and the age being written upon each certificate. The rules of statistical practice of the Bureau of the Census define that, "Children born alive and living for any length of time

whatever, no matter how brief, after birth, should not be classed as still-births, even though reported by the attending physicians or midwives as 'still-born.' Premature births (not still-born) should be included in total deaths. Premature births (still-born) should be classed under still-born and should not be included in total deaths." If a child is prematurely born, under term, the fact should be so stated upon the birth certificate, and also upon the death certificate if the case is still-born or dies soon after birth. This information will help to explain the cause of death. If the certificates are recorded as still-birth, the cause, as prematurity or other cause, should be recorded. Better statistics of the cause of still-birth are needed. In order to have more exact records of still-births a better understanding of what constitutes a still-birth is essential.

The varied legal definitions of still-births, as recorded in different vital statistics laws, seem to be due rather to a misunderstanding or lack of uniformity in the belief of what constitutes life rather than what measures the death of the infant. Death is a negative phase and should be considered as the absence of a living birth, rather than the reverse. The meaning of actual birth needs defining. Birth has been defined as the exact time when the head of a child is delivered, without reference to whether that act begins or ends the total delivery. It is often impossible to state, when the head emerges first, if the child will live or if the child at that exact time is actually alive. The life of the born child begins when the physiological function of respiration begins, even though the heart has been pulsating previously. A child whose lungs do not show, upon autopsy, evidence of established respiration is legally not born alive. If delivery constitutes birth and children are not alive until they respire, then no children are alive at the immediate time of birth, but all are still-births to be made living births by natural or artificial means. It therefore appears desirable for vital statistics laws to define that

birth occurs when a newly delivered child begins to breathe, and all infants which do not begin respiration are still-born. Such cases known to be healthy upon delivery and suspected of induced or permitted death through suffocation, drowning or chilling would necessarily be investigated.

Statistical studies of still-births in relation to diseases, to pauperism, to housing conditions, to various kinds of employment for women, to social and economic conditions and to paternal habits and crime are needed that future plans for decreasing still-births and their causes may be formulated.

In checking up still-births it is remembered that they usually constitute between 2 and 5 per cent of the total births. They are more numerous among the classes of higher society and of the working women and less numerous among the foreign born of the more primitive or lower races. They are usually more numerous in the city than in the country. Still-births are much greater among the illegitimate. Consequently, a high still-birth rate should show a high rate of illegitimacy; otherwise there is probably an evasion of the truth upon the birth certificates.

The objects to be attained in obtaining complete reports of still-births are, as recorded by Thomas,[1] to collect evidence for a statistical study of one cause of depopulation; to study the causes of early death; to increase the proficiency of those practicing midwifery; to safeguard the doctor when it has become necessary to induce abortion or hasten delivery; to remove motives for infanticide; to act as a check upon criminal abortion; to assure a proper disposal of the dead; to place a higher value upon infant life, and to estimate the fecundity of the different classes and nationalities of women.

The disposal of still-born children needs to be put on a uniform legal basis. The receipt of the death certificates

[1] Dr. Lee W. Thomas: *New York Medical Journal*, August 30, 1913.

should be followed by the issuance of special permits for disposal, which disposal should be done by licensed undertakers or by the local board of health. Copies of the permits issued should be filed at the board of health. The cellar or yard burial or home cremation of fœtuses which are old enough to become reported as still-births should not be permitted. Thomas suggested that the health departments should maintain a crematory to which still-born children may be sent, under the written request of the doctor, to be cremated by the health department. Such public cremation would insure more complete registration of still-births, would serve as a check upon infanticide and criminal abortion, would dispose of the bodies in a sanitary and inexpensive manner and would serve as a legal protection for the parents and the physician.

Premature birth statistics are needed that the influencing causes, maternal conditions, diseases and employment, may be investigated and improved.

Of the 28,270 deaths from prematurity of birth occurring in the Registration Area in 1914, 48.5 per cent were less than one day old and 20.2 per cent survived a week. In the Registration Area in 1914 the reported deaths from prematurity represented 11.7 per cent of the total deaths of infants under one year of age.

Infantile Mortality. — The completeness of birth registration is an index of health office efficiency, but the infantile mortality rate indicates the degree of social advancement of the community. The infant death rate, the ratio of the number of deaths to the whole population, is influenced by many factors which are of little importance and does not indicate the information most desired — the proportion of the babies which die. It is considered of little importance, therefore, and is supplanted by a more recent calculation. The infantile mortality rate is the ratio of deaths during the first year of life, to births. It is the per mille of babies who die within the first year of life,

being represented as the number of deaths per thousand births:

$$\frac{\text{Deaths of children under one year of age} \times 1000}{\text{Total births during the same year}} = \text{infantile mortality.}$$

The infantile mortality rates for the Registration States during 1911 varied between 86 in Utah and 206 in Maryland. The extremes of variation in the Registration Cities in 1911 were 82 in Richmond and 281 in Chicago.

For the sake of epidemiological consideration, infant death rates should be obtained for the first year alone, rather than to be grouped as of the first and second years inclusive.

DEATH REGISTRATION

Death registration is essential as a means of determining the aggregate health of a community, as an index of the virulence of an existing disease, as an indication of the needs of social improvement, and as a check upon the efficiency of improvements adopted for the advancement of social, economic, industrial or commercial conditions. Death records are a necessity as proof of death for the probation of wills, the settling of estates, the establishment of claims for insurance or pensions, and to prove parentage and ancestry. They are a requirement to obtain burial permits.

The United States Standard Certificate of Death should be the only form used or recognized by health authorities. Their universal use will provide uniformity in the data collected, in notation and arrangement, according to an authorized and standardized system.

The Registration Area comprises those states which have an adequate registration law and enforce it thoroughly. The law shall require the reporting of births and deaths and the issuance of burial permits. The registration of over 90 per cent of all deaths is required. In 1916 the Registration Area for Deaths included California, Colorado,

Connecticut, District of Columbia, Indiana, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, South Carolina, Utah, Vermont, Virginia, Washington and Wisconsin.

Certain cities, in nonregistration states, are accepted as having reliable statistics and are known as Registration Cities. The admission of single cities of small size is rather deprecated since their results are regarded by the Census Bureau to be of little statistical value and the enforcement of the law likely to be subject to irregularity. There is, however, no valid excuse for failure of complete registration of deaths or births in any city.

The original death certificates, those signed by the attending physicians and undertakers, being the legal and authoritative records, should be filed in the office of the state department of health, to be there bound and preserved in fire-proof vaults. No copy can be as good as the original. Owing to the danger of loss by fire or carelessness, these authorized reports should not be entrusted to the keeping of any local registrars. An exact copy of each birth and death certificate should be made and retained by the local registrar of vital statistics. These copies should be bound and filed in calendar order. Since vital statistics pertain rather to matters of health than to acts of law, the health department appears the logical depository for records of births and deaths, rather than that they should be retained in the office of the secretary of state, as is done in Rhode Island and Massachusetts.

Health officers should be appointed local registrars of vital statistics as they need to know what is occurring in their districts. By receiving these reports they are able to keep a check on the outcome of their efforts to control disease and obtain necessary information not learned in any other way.

Reports, including all original birth and death certificates, should be forwarded by the local registrars monthly to the state department of health, and not at the end of the year. The monthly reports enable the state department to determine the existing conditions or to refer to certificates when needed.

The indexing of birth and death records adds a convenience to the conducting of any health office. Some state departments card index every birth and death so that the individual records may readily be found. The indexing of births is especially desirable in view of the increasing demands for copies of birth records. These demands are usually made at the place of birth; therefore each city could increase the efficiency of the health office by forming an index which is separate from the state index. The cards may be indexed alphabetically under the names of the children, or under the names of the fathers when no child's name is recorded. The index card also states the date of birth and the folio and page number of the bound certificate.

A statistical complication is occasioned by birth, death and morbidity records of non-residents. In the present practice of statistical registration these are all included in the records of the registration locality in which they occur. But with some cross recording the work of health offices may be made more convenient, although somewhat complicated. A birth or a death of an individual may occur in a locality in which he resides but temporarily without his becoming an actual resident or citizen of that place. His birth or death is, of course, on record at that place, but his associates do not connect him with this distant town and in future years would not be apt to remember the place of birth or death. He is attached to the town of his residence, and upon that town's records should be enrolled his name and the other pertinent data. If he is born or if he dies in a hospital or institution in a town which is not his real

residence, or in a foreign port, a copy of his birth or death certificate should be forwarded from the place of birth or death to the health office of the residential town. This record should be marked "copy" and be filed separately from the records of the births and deaths of that town, in order that duplication of numerical returns shall not be made.

Through the usual registration of these visitors, hospital towns and cities have their birth and death rates unjustly raised at the expense of smaller communities deserving the credit. The usual filing of morbidity reports also results in injustice being done to cities supporting hospitals or to cities whose residents patronize summer resorts. Cases of infectious disease are frequently unjustly credited to cities in which the disease was not contracted. This is especially unjust, but is very difficult to correct. Every city in its published annual report should indicate the number of each communicable disease which was imported, and publish birth, death and morbidity rates corrected to apply to the actual residents of the city. Such reports would more clearly indicate the sanitary condition and needs of the city.

The completeness of death reports is largely insured by a legal fee being provided the local registrar or the undertaker. In Rhode Island the physician, the undertaker and the registrar each receives a county fee of twenty-five cents. Where reports are believed to be incorrect, some checking of the records after interviews with sextons, ministers, physicians, midwives or locally well-informed people may uncover unreported deaths. Birth records of still-births should be checked up on the death certificates. Reports of rural cases of diseases with a high mortality may be used to obtain a physician's complete statement of the diagnosis. A system devised by Watkins[1] for following up

[1] Dr. Frank L. Watkins, Registrar of Statistics, Florida State Board of Health.

coffin deliveries would produce a valuable check system. Each local undertaker is required to furnish monthly the addresses of persons to whom burial caskets have been delivered. In each casket shall be placed a blank death certificate and a printed notice requiring the certificate to be filled out and mailed to the state or local registrar.

Crude and Corrected Rates. — The sanitary conditions of two cities cannot be judged by a comparison of the actual number of people who are born, who are taken sick or who died in each city, unless the respective total populations are equal. Unless the size of the city is known the exact number of deaths can convey little information. Death rates are therefore used for comparison. The more exact the rates are calculated so as to apply specifically to the class of people involved — grouped according to age, sex, occupation, location or susceptibility — the more exact is the information conveyed by the rates. The rates are classed as crude when applied to the people as a whole, and termed weighted when only certain groups of people are represented in the rate, these distinguishing conditions being given special emphasis or weight, as it were.

The death rate of a community is a calculation based upon the present population of that special community. If the exact figure of the population is not known it is estimated from the rate of increase as shown by the last two federal census enumerations. To obtain the estimated population the difference between the last federal census and the previous one is determined. This difference will be the accepted numerical increase, or decrease, which occurred in that population during the intervening ten years. One tenth of this represents the average annual change. For the purpose of calculating death rates this annual increase, or decrease, is accepted as probably representing what has occurred during the intervening years since the last federal census. This figure is not the exact number of people who have been added to or subtracted from the total local

population, because the average change occurring during one decade will not correspond with that taking place during some other decennium, nor is the annual alteration constant. But the ratio must be used until the special community takes its own census annually or until the estimated census is based upon the birth and death rate fluctuations. The estimation of a population made by comparing the federal census with a local inter-federal census taken five years after the federal enumeration is not regarded so accurate as the calculation based upon two federal census counts. After determining the average annual alteration in the population, this number, per annum, is added to the last federal census. If five years have passed since the taking of the United States census, five times the average annual increase is added to the last general census enumeration to produce the estimated population of the community. When reporting death rates the method of determining the population is indicated; as, "Estimated Population, 1915," "Federal Census" or "Police Census."

The last federal census represents the population on April 15, 1910. An effort is being made to obtain a United States census every five years.

The police census is an enumeration by the local police, each police officer collecting the necessary data upon his beat. Like the federal census, the work of enumeration is completed within one day. An annual police census is desirable. It is now taken in Baltimore and elsewhere.

Assessors, in some localities, can obtain quite correct enumerations of the people. Their data blanks should include space for this purpose.

Crude Death Rate. — The crude death rate is the ratio which the total number of deaths bears to a thousand living population. It is obtained by multiplying the number of deaths by 1000, and dividing by the total population:

$$\frac{\text{Total number of deaths} \times 1000}{\text{Total population}} = \text{crude death rate per 1000 population.}$$

The crude death rate is that which is always reported and used for comparison unless particular statements are made to the contrary. In its calculation the number of deaths and the number of population always refer to the same area in the community, the given total population being that in which those deaths occurred. The population used in the calculation should not be taken from a larger community than that in which the deaths occurred. The total population and the total deaths from all causes occurring during the calendar year are used to obtain the annual death rate. For a state, a city or an institution for which the death rate is desired, the calculation is the same; the total deaths occurring only in the selected area and the population of that area alone being considered.

Institutional deaths should not be included in the general death rate. In computing the death rate of a city, if the institutional deaths are to be excluded, the deaths occurring within the institutions are not included in the number of city deaths, nor is the population of patients of the institution included with the city population number which becomes the denominator. If institutional deaths, those occurring in charitable homes, hospitals, asylums and jails, are to be included and calculated in the death rate, the separate populations of the various institutions should be included in the total population which is used in the calculation, if their combined census will materially affect the result of the calculation. In a small town they would affect the rate, but no duplication of enumeration should be permitted by counting the citizens who have already been recorded in the census of the community and are transients in the institutions. Where institutional deaths affect the rate for the community, and where the causes of those deaths are not traceable to the particular community in which the institution is located, a local injustice is wrought by crediting to that community those deaths, or those cases of pre-

ventable diseases. It is advisable to calculate those cases and deaths as institutional, and to report them as such. They thus may be credited to the state as a whole and not unjustly to any city, and be reported in the annual reports under separate headings. This is done in the reports of the Minnesota State Board of Health, separate reports being made for the various diseases and deaths occurring in hospitals, asylums and jails. Institutional death rates, calculated upon the population of the separate home, asylum, jail or hospital, should be reported by cities, with the necessary information describing the character of cases treated. Death rates are not necessarily indicative of conditions in hospitals, but if appearing inordinately low or excessively high an investigation may be advisable. Unreported deaths or obsolete methods of medical treatment may be uncovered.

Weighted Rates. — Weighted death rates or weighted averages constitute an important statistical practice necessary for true comparison. Vital conditions affect peoples according to different influences of susceptibility, environment or sanitation, or according to different arithmetical proportions. These factors are given weight or emphasis in calculating statistical evidence upon a comparable basis. In the matter of obtaining a view of average conditions the same theory is enforced; as an example, if in a group of 86 cases of typhoid 7 per cent died, and in another group of 94 cases 9 per cent died, the average percentage of deaths for the entire number would not be 8 per cent, but 8.04 per cent; thus:

$$\frac{(86 \times 7) + (94 \times 9)}{86 + 94} = \frac{1448}{180} = 8.04\%.$$

Influencing factors which have a bearing upon the points to be determined are considered in obtaining weighted rates. To determine if cancer is on the increase a misleading result will be obtained by calculating the ratio of

deaths from cancer to the total population. Only the deaths of these persons who according to age are apt to contract cancer should be studied. The cancer death rate is obtained by using the statistics of persons between the ages of 40 and 75. Between these ages is cancer most prevalent.

Therefore the cancer death rate is the ratio of the number of persons in this age group dying of cancer, considered to 100,000 living persons of this particular age group. In estimating the death rate from a specific disease the rate per 100,000 population is determined, whereas for general death rates 1000 is the population number used. Again, a further weight is necessary in correlating old records to consider the diagnoses of causes of death which may have been mistaken or recorded for cancer.

When comparing present records of any disease with past records a consideration should be given to mistaken or inexact diagnoses, making due allowance for diseases which were reported under a symptomatic or obscure name and which may have been cases of the diseases under investigation.

Other false methods of calculation are the inclusion of age groups in the numerator but not in the denominator. An age group is the number of people living between certain age limits, as between twenty and twenty-nine years. The limits as adopted are always inclusive in the period. The deaths of a certain age group can be compared with only the living of similar age, if statistical accuracy is to be maintained. Also the proportion of deaths from some particular disease, as cancer, to the total number of deaths will give unreliable information if used for comparison with other years or other localities. These rougher calculations result in errors which should be avoided.

Factors Affecting the Death Rate. — Race is a great influencing factor upon death rates, and the relative proportion of various peoples of different races included in

the total population will markedly affect the birth and death rates. A proportionally large foreign population from Eastern or Southern Europe raises the birth rate and very materially increases the infantile death rate. Negroes and Indians, especially susceptible to certain diseases, markedly affect the mortality rates. The death rates for the colored population should be estimated separately from that for the white. This is especially essential if the negro constitutes as much as ten per cent of the total population. In the west separate death rates are always calculated for the Indians. The general death rate of the Indians in 1909 was 25.5; whereas for the Registration Area for the same year the general death rate was 15.0. The necessity for separate registration of races is apparent.

Various influencing factors should be noted, considered and reported when local death rates are determined. A high death rate may be due to one or more of the unavoidable causes and a judgment of the sanitary condition of the community be misplaced. The antithesis may occur: these same factors operating under the opposite natural extreme may produce a lowering of the death rate in spite of unsanitary conditions and lack of effective public health work. A hot summer preceded by a cold winter will increase the death rate, whereas fewer deaths will occur if a warm summer is preceded by a warm winter, and the fewest annual deaths occur with a cold winter followed by a cool summer. The presence of war, of change in sanitary conditions, of scarcity of food, of accidents and industrial changes, variations in the density of population, various housing conditions, the character of the climate, weather and seasons, the changing birth rates and infant mortality all influence the death rates and need considering and recording.

The crude death rate forms a satisfactory method of comparing existing conditions with those of former years of the same community, but not of judging the equality

of one town with another. For judging the social or health conditions of different cities or localities, the factors which influence the death rates of the two places should first be learned and compared. Among the chief factors is the birth rate. The birth rate of a given city usually remains about stationary, or so nearly at a constant quietude or at a constant change that it would have but little effect upon the death rates of that particular community in a few years time. It can, therefore, safely be disregarded except for comparing different cities. If the city records show a declining death rate, it is safe to assume that the sanitary or living conditions of that city are improving. In judging the healthfulness of two cities a comparison of their crude death rates alone is not satisfactory. The birth rates of the respective cities exert such a marked influence that a correct conclusion can scarcely be approximated without their consideration.

A high birth rate will cause a high death rate; and, conversely, with a low death rate the presence of a low birth rate may be found. Considering the different ages, or age groups, as they are termed, the death rate is higher during the early years, especially in the first group below 5 years of age. The death rate is highest during the first year. In the Registration Area in 1914, 18.2 per cent of all deaths occurred in children under one year of age, the relative percentage of deaths for each age period markedly decreasing from this first period. A high birth rate produces more children and with their high infantile mortality, a high death rate results. One community having a higher birth rate than another will therefore have a larger population of children, and, with more children to lose, a resulting higher death rate, if the sanitary conditions of the two communities are equal. Conversely, if one city has a lower death rate than another it may have better sanitary conditions or else a lower birth rate and fewer children, or a greater adult population. Since one-fourth

of the new-born children die, a high birth rate adds three or more to the population, while it increases the deaths by one. If a high birth rate continues over a number of years sufficiently long to add many people to the middle years of the population, during those age groups when the death rate is low, there will result for that community a lowering of the death rate. An increasing population has, therefore, a lower death rate than has a stationary population. The growing town has a greater number of school children and young adults who do not materially add to the number of deaths but by their low mortality decrease the death rate. The average age of a population is the average of the sum of all the individual ages of those living members. The lower this average age, the lower ought to be the death rate. A high birth rate linked with a high death rate must be regarded as an indication of low sanitary conditions and inefficient health administration. It usually points towards excessive infant mortality. With the continuation of a high death rate in the presence of an increasing infant population, the health officer's chief concern and labor should be a study of the local conditions causing the high infantile mortality, and a rapid eradication of those causes. Infants form a delicate index to the sanitary status of a community. Their mortality rates, the ratio of infant deaths to births, should be constantly watched and improved.

Low birth rates and low death rates often coexist, but one is not the cause of the other, or dependent upon it, or a factor of it. Low birth rates come from economic conditions, late marriages, industrial depression and war. Low death rates come from long continued high birth rates, efficient health administration, good sanitary conditions and satisfactory housing and living conditions. Low death rates may also indicate incomplete reports, lax statistical office administration, or ineffective methods provided by law. A continuous low birth rate advances the average age of the population, apparently adding to the community a

greater proportion of old persons who are shorter lived, and hence the general death rate is made higher. Lowered birth rates result from an influx of foreign laborers. These foreigners are usually sturdy and hence the death rate falls, but their lack of knowledge how to live and work carefully may increase the death rate. In a few years these foreigners markedly increase the birth rate and, therefore, the death rate. A low birth rate, particularly a variable rate, in many instances should be suspected as indicating very incomplete reports. If a low birth rate long continues a more full reporting of still-births should be attempted. An improvement of birth registration increases with the birth rate and the death rate.

Errors in Death Certificates. — The accuracy of death certificates varies in different localities. Incompleteness of data is usually owing to the relatives or friends being misinformed or not being questioned, and is very common in the records from some hospitals. The family physician should fill the blanks while in the house of his patient, and should be particular to be correct in all details. Hospitals can largely overcome the frequent defect of omissions by obtaining the information from the relatives or friends early, or obtain the essential details from all the patients themselves. This practice is in vogue in some hospitals.

The occupation of the deceased should be carefully considered and correctly recorded upon each death certificate. The too free use of the word " laborer " is to be discouraged. This term of occupation should be limited to its correct usage. A laborer [1] is " specifically one who does work requiring chiefly bodily strength or aptitude and the little skill or training, as distinguished, *e.g.*, from an artisan (often with defining word prefixed, as agricultural, bricklayer's, dock, farm, mason's laborer, etc.)." The defining word should be included upon the death certificate. The careful notation of occupation, including the recording of

[1] Murray's "New English Dictionary."

the exact kind of work each artisan performs in his individual class, will assist very much in the statistical study of the effect of industrial conditions and occupational diseases. When an industrially acquired poison has been the cause of death, the specific kind of employment and the address of the place of employment should be included on the death certificate.

Errors in diagnosis or in recording the correct cause of death form the greatest factor in the unreliability of death certificates. One error results as the lack of appreciation of what is meant by the "primary cause" of death and what is intended by the "secondary or contributing cause." The primary cause is the disease which begins as the chief or fatal illness and is not that condition which immediately precedes death. A child with measles who has a fatal termination through broncho-pneumonia dies with measles as the cause and broncho-pneumonia as the contributing cause. With a cancer of the stomach, gastric carcinoma should be recorded as the primary cause and the secondary cause may have been hemorrhage or inanition. The causes of deaths of infants as they appear upon certificates are very unreliable. Marasmus so commonly given as a cause of death is often not a correct diagnosis.

Wilful misleading statements frequently occur in that part of the death certificates reserved for the causes of death. There is much deliberate suppression of such causes as alcoholism and syphilis. With some persons dying after surgical operations there is no mention of the operation and frequently no mention of any operable condition. Appendicitis cases frequently become labeled, after operation, as deaths from intestinal obstruction, even when clearly beyond the power of man to save. Various cancer cases become similarly misbranded as the surgeons fear a public exhibition of their records. Death records become the property of the state department of health and are not open to public gaze or reportorial criticism.

Incorrect geographical location of cases accounts for an important error in compiling records of vital statistics. Those cases living near the border of a ward, of a county or other registration district are occasionally accredited by the physician as living upon the wrong side of the division line, or the physician does not know the limits or borders of the registration district from which he should report the case as a resident. This error unjustly diminishes the rate for the district to which the case belongs, and unintentionally increases for the other locality the birth, death or disease rate, as the case may be. In an investigation of rural deaths in one of our best registration states the writer was unable to find in the state files the records of more than sixteen out of twenty-four rural deaths occurring within the last ten years. The places of death in one-third of the records investigated were not found to be recorded as having occurred in the localities which were declared by the relatives to be the true places of death. Two of the eight cases were recluses, well known, but buried by friends without permits and without licensed undertakers. The other six cases had regular undertakers but the death certificates were evidently lost by the local registrars or undertakers.

Maps giving the boundaries of the registration districts, with the name and address of the local registrars, when supplied or made accessible to the physicians having rural practice, would help to solve the difficulty and prevent errors from incorrect geographical location of cases. Many physicians living near or consulting beyond the boundaries of states, counties or registration areas do not know the local boundaries. They should acquaint themselves with the geographical data.

International Classification of Causes of Death. — A correct and comprehensive tabulation of the causes of death in all municipal and state reports is especially desirable. The International Classification of the Causes

of Death should always be employed. In classifying the causes of death the correct selection of the officially accepted cause of death and its official nomenclature is essential. Owing to the multiplicity of synonyms given to diseases, and to the difficulty in deciphering poorly written or misspelled names the causes of death should be read and determined by a person with the necessary medical training, that the oft-repeated errors in spelling or in duplication may be avoided. Two or more diseases are frequently given on death certificates as the cause of death. Statisticians follow the International Classification. Compilers may be assisted in deciding the disease which should be selected as the cause in order to be correctly classified according to the following rules:

STATISTICAL TREATMENT OF JOINT CAUSES OF DEATH[1]

1. If one of the two diseases is an *immediate* and *frequent* complication of the other, the death should be classified under the head of the primary diseases; for example:

Scarlet fever and nephritis, classify as scarlet fever.

Infantile diarrhea and broncho-pneumonia, classify as infantile diarrhea.

2. If the preceding rule is not applicable, the following should be used: If one of the diseases is *surely* fatal (apart from all treatment) and the other is of less gravity, the former should be selected as the cause of death.

Cancer and broncho-pneumonia, classify as cancer.

3. If neither of the foregoing rules is applicable, then the following: If one of the diseases is epidemic and the other is not, choose the epidemic disease; example:

Typhoid fever and endocarditis, classify as typhoid fever. Typhoid fever has preference over appendicitis.

Measles and biliary calculi, classify as measles.

4. If none of the three preceding rules is applicable, the

[1] "Manual of the International List of Causes of Death"; Second Revision, Paris, 1909, Bureau of the Census, 1911, p. 17.

following may be used: If one of the diseases is *much more frequently fatal* than the other it should be selected as the cause of death; example:

Pericarditis and appendicitis, classify as pericarditis.

Diphtheria is preferred to scarlet fever or measles.

5. If none of the four preceding rules apply, then the following: If one of the diseases is of *rapid development* and the other is of slow development, the disease of rapid development should be taken; example:

Pleurisy and senile debility, classify as pleurisy.

6. If none of these five rules applies, then the diagnosis should be selected that best characterizes the case; example:

Saturnism and peritonitis, classify as chronic lead poisoning.

Precise diagnosis should be given the preference over vague and indeterminate ones, as " hemorrhage."

When several diseases are reported as causes of death, the following rules should be observed:

1. The death is, as a rule, to be assigned to that number which represents the probable primary cause. With nephritis and heart disease, classify as heart disease; with debility and bronchitis, classify as bronchitis, a real disease.

2. With two independent diseases, the more severe should be taken.

3. With an infectious disease and a non-infectious disease, the former should be chosen; phthisis in preference to bronchitis.

4. If acute diseases are reported with chronic diseases, the acute diseases are to be preferred; croupous pneumonia in preference to gastric ulcer.

5. If two infectious diseases are reported, then smallpox, scarlet fever, measles, typhus fever, diphtheria, whooping cough, croupous pneumonia, influenza, typhoid fever, paratyphoid fever, Weil's disease, relapsing fever, cerebrospinal fever, erysipelas, tetanus, septicemia, puerperal fever, plague, Asiatic cholera, dysentery, anthrax, glanders,

rabies and trichiniasis should be given preference over tuberculosis, malaria or a venereal disease.

6. Causes of death from violence are usually preferred.

7. Such returns as heart failure, cardiac paralysis, paralysis of the lungs, pulmonary edema, coma and the like should be disregarded if other causes are named.

8. With tuberculosis of several organs, including that of the lungs, tuberculosis of the lungs should be selected.

Any one of the chief infective diseases is selected in preference to any other cause of death. Definite constitutional diseases have preference over local diseases, as, cancer over pneumonia. When apoplexy appears with disease of the heart or kidneys, the heart or kidney disease is selected. Embolism has preference to hemiplegia.

The disease of longest duration is selected if the foregoing rules are not thereby disregarded.

Violence, when specifically defined, is given preference over other consequences. The cause is given first choice over the result; as, explosion in a coal mine is selected rather than crush or fracture of skull.

Physical diseases, as tuberculosis, are preferred to mental diseases as the cause of death, but general paralysis of the insane is a preferred term.

Puerperal causes are preferred, except when a serious disease (*e.g.*; cancer, chronic Bright's disease) was the independent cause.

Indefinite terms and titles are disregarded for definite ones.

MARRIAGE REGISTRATION

Marriages constitute a social index of a community, and are recorded statistically for the purpose of discovering causes of social unrest, of changes in population, obtaining family rates, and for determining changes toward foreign nationalism, the effect of mixed marriages, and as a check upon the eugenics of the future race. An increase in the

laboring population or in the foreign population, an increase of children of foreign parents or an increase of late marriages of native citizens, call for attention from the health and social authorities — for each change of social condition will produce its own problems for solution. These changes are noted through a registration and compilation of the marriages. The proportionate number of marriages of American-born parents in Providence decreased 10 per cent in fifty years. This decline gives an apparent increasing foreign tone to that city, but the change has been made through the consummation of mixed marriages rather than through the marriage of parties both of whom were foreign. Mixed marriages produce a more rapid Americanization of the foreign-born parents and of their children, and hence bring these immigrating peoples under a better understanding of the American customs.

Marriage registration is an aid in establishing proof of legitimacy and inheritance. It strengthens and protects the bonds of matrimony.

MORBIDITY REGISTRATION

The statistics of morbidity, or sickness, serve as special indicators of existing conditions, a rôle which cannot be filled by death rates. Morbidity statistics reveal the presence of the existing diseases; death rates, the final effect these diseases have had upon the community. Morbidity reports proclaim immediate needs, but death rates are the aggregate results. Morbidity rates are individual, economic and of the present; mortality rates concern losses which are broader, irreparable and of the past. Morbidity rates are a check upon professional diagnostic ability and of public health activity; mortality rates indicate the advance of medical science in the treatment of disease. Morbidity is dependent upon susceptibilities and the lack of control of the infections; mortality is usually irrespective of the amount of illness present, but depends

upon virulence, lack of human resistance and upon limitations in medicine.

Morbidity statistics are collected for the purpose of studying existing diseases, their location and prevalence; in noting the effect exerted upon diseases by economic, social, living or industrial conditions; the effect of race, age, sex and congestion of population; the modes of transmission of disease; the case rates and the fatality rates; the effect of isolation and quarantine; the shortcomings of fumigation; the effect of special protective measures, as vaccination; the effect of methods of treatment; to learn susceptibilities and to prognosticate the appearance of an outbreak; and to determine the efficiency of men, of health officers, of laws and of methods.

The term "morbidity statistics" usually has reference to statistics of only the communicable diseases which by law are made reportable. Actually, the term may refer to any collected data having reference to sickness.

Morbidity reports should be made to and be kept under the control of an epidemiologist. Mortality reports are received and filed by the registrar of vital statistics. The qualifications essential for the appointment of an epidemiologist should include a medical degree from a first-class medical school and special training and experience in the diagnosis and control of communicable diseases. A medical training is not necessarily essential for a registrar of vital statistics, but the registrar should be a good accountant, quick to discern errors and competent to direct those in his employ.

Cooperation between the various bureaus of a department of health is essential for great efficiency. This activity consists in the submitting to other bureaus of reports which can be of special assistance. In the detection and control of the infectious diseases the statistical assistance is of the greatest help. The reports should be made to the epidemiologist. The laboratory should report the

name, age and address of each person on whom is made a positive diagnosis of diphtheria, typhoid fever, tuberculosis, syphilis, gonorrhea, malaria, hookworm disease, meningitis, rabies, anthrax, glanders or other infection. The bureau of vital statistics should report to the epidemiologist deaths from the acute communicable diseases — diphtheria, scarlet fever, typhoid, measles, whooping cough, smallpox, cerebrospinal meningitis and poliomyelitis. The bureau of medical inspection of schools reports such cases of contagious or infectious diseases as are discovered in the schools or in the houses of the school children. The department of factory inspection, by reporting suspicious cases of communicable diseases which are found in industrial establishments, would be of great assistance. Visiting district nurses, dispensaries and charity organizations should submit similar reports; and from employment agencies further information may be solicited. All these reports are collected and used for the purpose of locating, detecting and controlling the dangerous cases of infectious diseases. The epidemiologist compares these reports with his existing records, thereby locating new cases and learning of new foci, extensions and sources.

Morbidity reports should be received from physicians on printed postal cards which are furnished by the state or municipal health departments. Reports by telephone are preferable to no reports, but physicians should not expect that their oral reports are satisfactory or accurately copied. Diseases requiring immediate reporting should be reported by telephone or telegraph, a postal card report following to confirm the verbal message. The diseases to be reported immediately by wire should include diphtheria, virulent smallpox, bubonic plague, cholera, yellow fever, typhus fever. When the doctor's orders in regard to the isolation of persons having measles, diphtheria, scarlet fever or mild smallpox are disregarded, and in local instances in which there is danger of immediate transmission of the

infection through milk or a public water supply, as with typhoid fever, the information should be telephoned to the health officer.

The variance of morbidity statistics has been noted many times, and has frequently led to inaccurate conclusions. If the records of cases and deaths of a certain disease are complete, and are of sufficient number to establish a definite ratio, they will indicate the fatality rate of that disease for that particular locality and time. But the usual published statistics are too incomplete to establish a definite fatality rate, and when compared with other reports show marked discrepancies. Dr. John W. Trask has shown the marked variation in the published fatality rates, by a comparison of the ratio of deaths to cases as reported to various boards of health. The cases for each typhoid death varied from 4.9 to 8.4, these being averages of the previous six years. It is generally considered that about one-tenth of the typhoid cases succumb, while some declare as high as 15 per cent are fatal. To report that the ratio of cases to deaths is as low as 8 or 9 per cent is not necessarily a presumption that the infection is of especially low virulence, but is more of an acknowledgment that the health officer has been unable to obtain complete reports. In those states which have state health departments of increasing efficiency there is a gradual rise in the number of cases reported to each death, showing the improvement of the methods adopted to collect morbidity statistics. With more or less stationary health departments the ratio of cases to deaths shows little change from year to year, or else exhibits intermittent waves. There is, however, a varying virulence of diseases which produces fluctuations in the fatality rates.

Reports of communicable diseases are obtained in various ways, their accuracy being chiefly dependent upon the activity of the local health officer and upon his available assistance. Reports of a town having but a few cases of

one of the more contagious diseases chiefly indicate that the returns are probably inaccurate and incomplete; with the diseases whose infectiousness is transmitted less readily there may be but few cases existing. In either instance the returns as published by the health office may not be complete. It can scarcely be expected that a highly contagious disease, as measles, can long continue in a city without infecting relatively many people. The greater the inaccuracy occurring in reporting, the greater will be the danger to the involved town and also to the surrounding communities, as many cases escaping detection escape control. If the health officer relies only upon the reports received from physicians the records of the cases not seen by the physicians will be missed. Other errors in the completeness of morbidity statistics occur when two physicians see the same case and each supposes the other reports the case. When secondary cases occur in a household some doctors thoughtlessly suppose it was the house and not the case which was to be reported; and also often a physician, without the opportunity of seeing many cases and different aspects of the particular disease, fails to recognize a mild form or refuses to report a severe form of the disease. The influence which these causes of omission will exert upon statistical accuracy is shown in a year's record for one small town.

INCOMPLETENESS OF REPORTS IN ONE SMALL CITY IN 1913

	Cases reported by physicians.	Cases known to exist.
Chickenpox	10	41
Diphtheria	8	12
Measles	117	367
Scarlet fever	14	19
Smallpox	29	49

Many of these unreported cases were mild and had seen no physician, but they were infectious nevertheless and should be controlled. Some were secondary cases which the doctor failed to report, while he attended the first case. The unreported cases were located by the writer, the health officer, by inspections of the reported house, inspections of the neighborhoods, visits to all school children absent four days from school, and by following up rumors received from the public and by visiting children who had been in contact with the patients.

A health officer should use every legitimate means to detect disease and to prevent its spread. Much may be gained by newspaper requests for public cooperation and reports of known cases. The public is always willing to report and assist in the apprehension of murderers, burglars and other similar lawbreakers, but has not yet learned of the necessity of helping the health officer to check and to prevent the indiscriminate spread of disease and death by the law-breaking disseminator of disease germs. In the smaller communities and towns this helpfulness can be obtained through newspaper assistance, public lectures and exhibits. An instance of this effect was the voluntary reporting by the public of 23 per cent of the known cases in a measles outbreak. In this outbreak of 320 cases of measles the cases became known to the writer as health officer through the following channels:

SOURCE OF REPORTS RECEIVED IN MEASLES OUTBREAK

Physicians.	Parents.	Neighbors.	Teachers.	Found by health officer.
27%	13%	5%	5%	49%

Nearly half of the cases were located by tracking up school absentees, whose cause of absence was unknown; by visiting children known to have been exposed; by visiting the

children who were found by a school disease census to be probably susceptible; and by finding and including in the list the secondary cases which had not been otherwise reported. The term "secondary" is herewith intended to include only those subsequent cases occurring in a family already having one case of the disease. Reports of a few cases of disease may be obtained by the health officer publishing a statement that he will, upon request, visit houses for the purpose of making diagnoses of disease in those unable to pay a doctor.

Report Cards.—Report cards for forwarding information of the presence of infectious diseases may contain blank spaces for the hour and date of making the report; for the name, age, sex, color, nativity, occupation and address of the patient; the name of the disease with the date of its onset; the name of the householder and his occupation; the number of school children and the addresses of the schools attended. If free antitoxin is given or free vaccinations are made by the official medical inspector, blank spaces for recording the doctor's request in reference to the giving, the number and the doses desired, should be included. A list of all the diseases required to be reported should be on the report card. If the card also asks the question, "Is this the first case in this house?" the health officer will know without referring to the files if the house has been placarded and the people warned of the dangers, and also the doctors will be more apt to report secondary cases. In the case of smallpox, information should be obtained in reference to vaccination, asking for the date of the last successful vaccination, if done within seven years, if previously or if never done.

Reciprocal Notification. — Statistical cooperation between states is needed. A state should be notified of the outbreak of any communicable diseases in the adjoining counties of the bordering states, that a search for the earliest invading cases may be immediately begun.

The practice of Dr. A. J. Chesley, epidemiologist of the Minnesota State Board of Health, of notifying the local health officers of other states needs universal adoption. A report is sent to the local health officer of any locality in another state to which a case of communicable disease emigrates from Minnesota in order that immediate steps may be taken to control the infected people and check the spread of the disease. Whenever a case of a reportable disease comes into Minnesota from another state, or is reported from the same state, the health officer of the city or district from which the patient came is requested to search for and report the original source of infection. By this careful interrogation regarding the patient's travels, and through the inter-state or intra-state correspondence, many unknown cases of disease and many unsuspected sources of infection may be discovered and controlled.

Since complete morbidity statistics become a necessity to the health officer, it is his duty to exert efforts toward their compilation. This may be done in a number of ways, the effectiveness of which depends upon the size of the community he serves. In large cities health officers are compelled to rely upon the reports from physicians and hospitals, and from school and other inspectors. The police force may occasionally be used to obtain evidence of cases of contagious disease. Teachers, school children and charity workers can give much assistance in locating cases. A general appeal to the public, through the newspapers, may be effective. This, however, is apt to fail with quarantinable diseases since there is a general public tendency to resist the placarding of houses. The dread of house placarding and quarantine, founded upon a misunderstanding of the value of protection and how it may be obtained, decreases when the people are taught the motives and reasons.

Incomplete statistics are preferable to no reports, but the deficiency should be recognized. A few reports permit of

a few foci of infection being controlled, and indicate that the disease is present and probably quite prevalent. Municipal and state reports should give some indication of the correctness of their statistics. The report on the presence of a disease can state that the number is believed to be complete or partial, or that cases are known not to be reported, or that the report probably includes only one-fourth of the cases. Such admission would indicate greater reliability, increase respect and stimulate greater effort. Incomplete statistics are not wholly a fault of the physicians, nor always a correctable delinquency of the health office. Physicians' reports increase proportionately with the severity of the disease or the infection, and the completeness of health office work is largely a matter of appropriation. In the presence of light infections when there are no alarming symptoms, and after outbreaks of communicable diseases have become so general that parents make their own diagnoses, the doctors see few cases and make proportionately few reports. Secondary cases can be located by the health officer if the report blank contains a space asking for the number of susceptible children or persons in the family. At the termination of the period of incubation the local health officer, by tracking up these exposed susceptible children, may discover new cases.

The correctness of morbidity reports is vitiated largely through the fact that physicians do not see many of the cases of the communicable diseases and the general public has not yet been taught to realize the necessity and value of complete records. When an outbreak of some disease occurs in a community many persons, not realizing the protection offered by the health office, refuse to admit having sickness within their home and even neglect to call a physician, for fear of quarantine and through the delusion that a yellow placard on the door means social ostracism. They should be taught, through the newspapers and through the schools, that isolation of the infected is a

mutual protection and that placards when placed on the front and rear doors to warn people to keep away and avoid disease raise the estimation of the neighbors. The public always has a higher esteem for those who warn them of impending danger.

Reports of communicable disease should be made to the local health officer immediately upon making a diagnosis, and be forwarded each week to the State Department of Health.

CHAPTER III

THE CONTROL OF COMMUNICABLE DISEASE

The control and eradication of communicable disease is the chief duty of the health officer and the goal of all public health work.

All the communicable diseases should be made reportable diseases, to be reported by the physician to the health authorities. There are certain other diseases, as pellagra and cancer, which are also made reportable.

The more common diseases which are required to be reported in various states are as follows:

Cancer	Pellagra
Cerebrospinal meningitis	Pneumonia
Chickenpox	Poliomyelitis
Diphtheria	Scabies
German measles	Scarlet fever
Gonorrhea	Septic sore throat
Hookworm disease	Smallpox
Impetigo contagiosa	Syphilis
Malaria	Tuberculosis
Measles	Typhoid fever
Mumps	Whooping cough
Ophthalmia neonatorum	

The uncommon or rare diseases which are legally reportable are as follows:

Actinomycosis	Barber's itch
Amebic dysentery	Beriberi
Anthrax	Changres fever
Asiatic cholera	Dengue
Bacillary dysentery	Erysipelas

Favus
Glanders
Leprosy
Paragonimiasis
Paratyphoid fever
Plague
Puerperal fever
Rabies
Relapsing fever
Rocky Mountain spotted-fever
Tetanus
Trachoma
Trichinosis
Typhus fever
Yellow fever

It is important to determine the exact time it requires a disease to develop after the infection has been received. This is termed the period of incubation. The length of the incubation period varies under different conditions. A person after becoming infected cannot convey the infection until after the minimum period of incubation has past, therefore isolation is unnecessary before this date. After the maximum time has passed a person may be released from observation and custody if symptoms of the disease have not appeared. The period of incubation varies with the disease and apparently with the virulence of the infecting organisms and the resistance of the person.

INCUBATION PERIODS

Disease.	Usual time in days.	Extreme variations.
Asiatic cholera	1–3	1–14
Anthrax	3–6	....
Bubonic plague	3–4	3–10
Cerebrospinal meningitis	1–4	....
Chickenpox	14–17	4–21
Diphtheria	1–4	1–14
German measles	10–12	5–21
Glanders	3–5	....
Gonorrhea	4–7	4–14
Hookworm disease	6–10 weeks	....
Malaria	10–14 days	....
Measles	7–12	7–25
Mumps	17–20	14–25
Ophthalmia neonatorum	2–4	½–5
Poliomyelitis	3–8	2–16

INCUBATION PERIODS (Continued)

Disease.	Usual time in days.	Extreme variations.
Rabies	6–8 weeks	2–12 weeks
Scarlet fever	2–5	4 hrs.–21 days
Smallpox	10–14	8–17
Syphilis	14–42	10–90
Tetanus	5–10	2–27 or more
Typhoid fever	14–21	3–21
Typhus fever	5–12	1–21
Whooping cough	7–14	2–17

Isolation. — The isolation of people ill with infectious diseases must be maintained during the period of infectivity. The infectious people should be rigidly separated from the avenue or agency by which the disease is transmitted. Malaria cases must be kept away from *Anopheles* mosquitoes, typhus cases away from lice, typhoid from flies. Where the disease is transmitted by contact, susceptible people must be barred from seeing the patient, as in scarlet fever, smallpox and measles. Where the disease may be conveyed to anybody through the secretions of the nose and throat — as with diphtheria, tuberculosis and poliomyelitis — this transmission should be stopped. Where the contagion can be carried from the house by empty milk bottles — typhoid, diphtheria, scarlet fever, septic sore throat and tuberculosis — the leaving of milk bottles by the milkman at the house should be prevented. Where the disease may be transmitted by dirty fingers and careless handling of the patient — as in typhoid, tuberculosis and diphtheria — rigid measures should be taken to minimize the danger. And lastly, when artificial immunization of the susceptible persons is possible — diphtheria, typhoid, smallpox, and possibly in scarlet fever and other infections — the protection should be offered and the people be encouraged or compelled to adopt it. Since in the infectious diseases, except in malaria, one severe attack usually grants per-

manent immunity, children who have had a previous attack of the disease may provisionally be accepted as immune and be accorded the same liberties which are given adult members of the exposed family. The periods of isolation herewith presented are arbitrary selections, and with the development of more knowledge of the transmission and infectivity of diseases, changes will be made in the schedule. The lack of uniformity in the laws and regulations indicates the need of stronger evidence of the modes and limits of the transmission of infection.

ISOLATION PERIODS

Chickenpox: *Patient* — Isolate until all crusts drop off.

Susceptible children — One week after first exposure isolate until three weeks have past since last exposure.

Other members of family — No restriction; may live in same house and attend business or school.

Diphtheria: *Patient* — Until two successive cultures at two-day intervals from both the nose and throat fail to show virulent diphtheria bacilli.

Other children — From first exposure until one week after last exposure, unless immunized, and after one negative culture.

Other members — Isolate from patient. May attend to business after one negative culture, unless engaged in handling milk.

German Measles: *Patient* — Isolate for seven days after appearance of eruption.

Susceptible children — Exclude from school if any symptoms appear.

Other members — No restrictions.

Malaria: *Patient* — Isolate after sundown within screened house.

Others — No restrictions.

Measles: *Patient* — Isolate for two weeks after beginning of symptoms, or until all nose and throat signs have dis-

appeared and all symptoms and discharges referable to the head have ceased.

Susceptible children — Isolate for two weeks beginning seven days after first exposure.

Other members — No restrictions.

Mumps: *Patient* — Isolate until after all swelling and tenderness disappear.

Susceptible children — Ten days after first exposure exclude for ten days.

Other members — No restrictions.

Scarlet fever: *Patient* — Quarantined for minimum period of three weeks and thereafter during persistence of hyperemia of skin or throat, or other nasal or pharyngeal signs, unless mildness of case permits shortening of quarantine period to two weeks.

Susceptible children — Separated from patient and isolated for two weeks since last exposure, unless immunized. If not separated, are quarantined full time.

Other members — If separated from patient, may attend to other business except handling of food.

Smallpox: *Patient* — Quarantine until all crusts have dropped off skin lesions.

Other members — With malignant smallpox, all other resident members should be immediately vaccinated and quarantined until the recovery or death of the patient, or for a period of not less than three weeks. With mild smallpox, members not successfully vaccinated within ten years should be vaccinated immediately and quarantined for two weeks. Members recently successfully vaccinated and showing good scars may be permitted to attend business.

Tuberculosis: *Patient* — Isolate as long as tubercle bacilli are found in the sputum, the isolation being especially rigid respecting eating and sleeping. Strictly observe careful collection and disinfection of all sputa, body discharges, soiled linen and eating utensils.

Other members — Those who become frequently exposed to the patient must not engage in any business requiring the handling of food, work in laundries, in the manufacture or handling of wearing apparel, confectionery or cigars, nor attend school.

Typhoid fever: *Patient* — Isolate until recovery and until urine and stools are free from typhoid bacilli.

Other members — Immunize with typhoid vaccine, unless previously immunized by an attack of typhoid fever. The nurse should not cook nor handle the food, bedding or laundry of the other members of the family.

Whooping cough: *Patient* — Shall be isolated for a minimum period of three weeks and thereafter as long as the whoop or paroxysmal stage persists.

Susceptible children — Remove from patient and exclude from school and young children until two weeks have elapsed since last exposure, unless immunized.

Other members — No restrictions.

Quarantine. — The term quarantine receives different interpretations in various localities. By some authorities the term is applied to simple isolation, attendants of the patient being permitted egress. Only the term isolation should be applied to such a method of controlling the infectious. When a patient is thus isolated, those people who have had the disease and are immune, or who have been artificially immunized, may be admitted to the house. Diseases controllable by these methods would include measles, mumps, whooping cough, rubella, pneumonia, chickenpox and mild smallpox. Visitors to the rooms of cases of typhoid fever, tuberculosis, paratyphoid and pneumonia should not be permitted to touch the patient or to attend to the wants of the sick. Cases of diphtheria, scarlet fever, meningitis, poliomyelitis, virulent smallpox and of the rare malignant communicable diseases should be kept in absolute quarantine when treated in their homes, nobody except physicians and nurses being permitted

to enter and leave the premises. When necessary to enforce complete quarantine police guards should be placed.

Quarantine without Inspection. — Where a health officer is so situated or provided that it is impossible for the health officer or his agents to visit the cases of contagious disease for the purpose of establishing or terminating quarantine, some provision may be made for conducting quarantine and isolation without inspections. This is the lowest grade of quarantine practice, but is much better than no efforts whatever being made to check transmission of disease. The quarantine, under these conditions, will be a time limit quarantine. Under this method quarantines are necessarily much prolonged over those terminated by bacteriological examinations and inspections. The time for excluding the children from school would be the same as the time limit for quarantine, a child being admitted to school at the termination of quarantine.

Time Limit Quarantine

Chickenpox	16 days
Diphtheria	21 days
German measles	16 days
Measles	16 days
Mumps	16 days
Scarlet fever	30 days
Smallpox	30 days
Whooping cough	30 days

The operation of this simplified, modified system is chiefly clerical. When a physician reports a case of communicable disease the household is notified of the length of quarantine to be observed. The physician is furnished with placards and is requested to placard the houses in which are located his cases of placardable diseases. The acting health officer possesses a map upon which are located the various schools and their district boundaries. By having the

address of the patient, as furnished by the physician, the health officer notifies the school of that district that all the children from that family and address shall be excluded from school for the period of time herewith given in the table of time-limit quarantines, giving dates for future admission. The time of isolation for German measles is made equal to the isolation period of measles to prevent measles cases being surreptitiously reported as German measles. In all cases the diagnosis of the practicing physician is accepted. At the termination of the quarantine period the household is notified by postal that they are authorized to remove the placard and to attend school and the places of business from which they have been excluded.

This modified method of control of contagious diseases is not the most satisfactory, nor the most just or efficient, but it is much better than the methods, or lack of methods, now frequently observed in many small towns and rural districts. No medical knowledge is necessary for its usage; it would, however, be of service where the health official is a layman.

Some epidemiological work can be done where this system is in vogue, by requests for information being made, by telephone, or printed return-postal sent to the family of the patient. The data requested would include the date of onset of symptoms, places visited by the patient after that time, and the names and addresses of people known to have been exposed. These people are warned of what suspicious symptoms to expect and what to do to prevent the spread of the infection. The school authorities may be notified to exclude such exposed susceptible children for the period of time previously detailed in this chapter.

Placards. — Placards should be placed at the front and rear entrances to all houses, apartments or premises containing certain cases of contagious or communicable diseases; to wit, anthrax, bubonic plague, cerebrospinal meningitis, cholera, chickenpox, diphtheria, malaria, measles,

poliomyelitis, scarlet fever, smallpox, tick-fever, typhoid fever, typhus fever, yellow fever and whooping cough. Houses containing careless persons with pulmonary tuberculosis should be placarded.

Placards should be of sufficient size and distinctive color or lettering to be noticed from across the street; the printing of the name of the disease should be readable from beyond the steps or front gate. The display of blank yellow flags as warnings or as an indication of quarantine is not sufficient or safe, as many people suppose them to be displayed for other purposes. Placards printed upon muslin are the most desirable; they are the most convenient to carry, are readily tacked up, can be used repeatedly, and will not blow or wash off. Gummed, thin paper placards crack and tear easily, they are bleached by the sun, and are washed off by heavy rains, adhere to each other during wet weather, are difficult to remove from brick surfaces and they ruin varnished woodwork. Heavy cardboard placards are very inconvenient to carry and they often tear by high winds. An efficient health officer will always carry some muslin placards folded in his pocket, and a few tacks. When placards are tacked the tacks should be driven where they will not deface, and should be removed with the placards. The use of a coin facilitates pushing in the tacks by the thumb, and also in their withdrawal. Placards should be posted at the earliest possible moment after location of the case, and removed at the earliest time when the period of known infectiousness has passed. If disinfection is practiced, the placard should be removed by an official at the time the disinfection is performed.

Milk placards are used to prevent bottles of milk being left where there is danger of the bottles becoming infected, thereby serving as carriers of disease to other households. These milk placards may read; " Notice To Milkman. A case of contagious disease exists in this house. Bottles of

milk are not allowed to be left here while this placard remains up. Householders are required to place outside a jar or pitcher into which milk may be poured. This placard shall be removed only by the health officer." Such a notice needs local legal support. The milk placard should be displayed at the front and rear entrances, and so located that the milkman cannot fail to see it.

A town well placarded means a safe town, a careful community and an efficient health organization. A town showing no placards of disease on the houses may be very free from disease, which is scarcely likely to continue long, or it may be a community lax in health administration, careless with the infectious cases and decidedly dangerous to itself and to its visitors. A strict search for all cases, their isolation and an efficient placarding of all houses which are dangerous, with frequent truthful newspaper reports of actual conditions, will overcome prejudice and disease.

In addition to the warning signs placed upon the outside of houses harboring communicable diseases, there should be tacked upon the door of the sick-room cards giving full printed directions describing the nature of the specific disease, how it is transmitted and detailing necessary directions for the care of the patient and the household. These cards should be printed in the language of the house.

Personal placards, as printed arm bands worn upon the coat sleeve in whooping cough, are probably useless to prevent transmission, as people are careless and will not heed the warning. People either will not or cannot read such signs, or else will come close to the individual to read the notice, thereby becoming infected. If a child with whooping cough is given the liberty of the streets any placard he wears upon his person will not materially minimize the danger of his transmitting the disease.

Funerals. — The funerals of those dying of contagious disease should be conducted according to the modern ideas

of disease prevention, with the sole object of preventing the well from contracting the disease. All cases dying of infectious disease should be encased in air-tight coffins or caskets, except when dying upon the high seas. Cremation is preferable to burial, especially for the tuberculous. No dead body should be consigned to any lake or river, nor to the ocean within one hundred miles of any shore. Interring and disinterring should be prohibited to anybody except licensed embalmers, sextons and authorized military, naval and marine commanders. The attendance at the funeral of anyone dying of smallpox, spinal meningitis, poliomyelitis, scarlet fever or diphtheria should be limited to the members of the household living in the premises during the illness of the patient, and to the physician, nurse, minister and undertaker. The burial of these cases should take place from the house in which the patient died. No funeral of any person dying from tuberculosis should be held in the rooms in which the fatal illness occurred. The bodies of persons dying of infectious diseases should not be exposed to the touch of any persons attending the funeral. The lids of all caskets containing the bodies of people dying of infectious diseases should not be held down by screws or bolts, but should be securely nailed to prevent their being opened surreptitiously.

DISINFECTION

The disinfection of houses has justly been relegated to a minor position in the control of infectious diseases. Since the transmission of the contagious exanthematous and some other diseases occurs from infectious persons and rarely, if ever, from inanimate objects, the persons who are the carriers of disease should receive the attention. Fomites, dust, empty rooms, books and other objects handled by sick persons deserve little consideration in the practical control of disease, except in certain rare instances. There are, however, certain other objects which receive deposits

of pathogenic bacteria from the mouths of persons having certain infections, and these objects deserve special notice; as, for example, public drinking cups, public towels and public lead pencils. To this category belong a few objects of lesser importance which, however, need official control or condemnation — such objects as cigar clippers, certain accessories used in barber shops, publicly used finger-bowls, certain objects of public school usage, as pencils, which are apt to become of objectionable public use, and other objects which may have some influence in transmitting a few cases of disease. The disinfection of dairy utensils, of water supplies, and of the containers for certain foods, is an entirely different question, as are the various purposes of surgical disinfection.

The bedding and clothing used by a person having diphtheria, meningitis, scarlet fever, smallpox, tuberculosis, poliomyelitis and typhoid fever should be thoroughly disinfected by boiling or by formaldehyde. This would include the pillows and mattress. I recommend the burning of the pillows which have been used by scarlet fever or tuberculosis patients. The clothing and bedding used by a person with anthrax or glanders should be burned. The only real purpose of room disinfection is the sterilization of non-washable clothing and bedding which have become recently infected and can be readily disinfected by formaldehyde gas.

Room disinfection following cases of communicable disease is usually unnecessary or useless. No dependence should be placed upon room disinfection as a supposed method of eliminating disease. It is of very minor importance to the discovery and control of disease carriers. Following long occupancy by a case of open tuberculosis, formaldehyde disinfection of a room may be of some service. It may be of value provided the gas concentration in the air is not less than one pint of formaldehyde saturated solution to every thousand cubic feet of room

capacity. Fumigation may be of some service after diphtheria but it is of much less importance than a search for the carriers of virulent diphtheria bacilli. It is useless to disinfect a schoolroom for diphtheria unless all the children have been repeatedly cultured and all carriers removed.

Formaldehyde gas is the only known disinfectant worth considering for room disinfection. Fumigation by formaldehyde is done by either of three methods — spraying under pressure, by the wet sheet method or by the permanganate process. Used by any of these methods it is not safe to employ less than the proportion of 10 ounces of the saturated, 35 to 40 per cent solution of formaldehyde for every one thousand cubic feet of air space to be disinfected. McClintic recommended[1] 10 ounces of formaldehyde to be used where the atmosphere is warm and humid, but where cold and dry, double the quantity. Bacteriological tests have substantiated the claim that this much formaldehyde is necessary for complete effect.

After the fumigation is finished the odor of formaldehyde may be quickly dispelled by neutralizing it with ammonia. An amount of ordinary washing ammonia equal in quantity to the volume of formaldehyde solution used, or about half this amount of stronger ammonia (26°), is sprinkled around the disinfected room. Thorough ventilation by opening all windows will also serve to let the fumes escape.

FORMALDEHYDE-PERMANGANATE DISINFECTION

Formaldehyde, 40 per cent solution.......	1 pint
Diluted with water........................	2 ounces
And poured upon potassium permanganate crystals, in a pail inside a wash-tub...	7 ounces

The permanganate crystals are emptied into a deep pail and the slightly diluted formaldehyde then poured

[1] Dr. Thos. B. McClintic: "Disinfectants, Their Use and Application," *Public Health Reports* No. 42, 1912.

upon the dry crystals. In about fifteen seconds a violent ebullition begins and a dense column of formaldehyde gas is soon evolved. The gas becomes quickly diffused throughout the room. All openings leading from the room should be sealed with gummed paper or strips of newspaper wet and plastered over the openings; the openings include chimney openings, fireplaces and ventilators, window and door cracks, keyholes and cracks in the walls or flooring. The foregoing quantities of chemicals should be used for every one thousand cubic feet of capacity of room space. The room should remain sealed and closed twelve hours. It has been proved that any smaller amount of formaldehyde than ten ounces per thousand cubic feet will not completely disinfect, and sixteen ounces is best. In the Public Health Service ten ounces of formaldehyde solution and five ounces of permanganate are usually used. No solid or other substance from which formaldehyde gas is alleged to be liberated should be relied upon or used, unless it is proved that the amount of gas evolved is uniform in amount and unless sufficient material is used to produce the same amount of gas as is contained in one pint of a 35 per cent solution of formaldehyde. No reliance whatever should be placed in the so-called formaldehyde candles, as they produce but a small amount of gas and that in greatly varying and unknown proportions.[1]

In conducting the disinfection there are certain precautions to be observed. There will not be a proper evolution of the gas if full strength formaldehyde is used undiluted. Dependence should not be placed upon any formaldehyde solution which is not labeled as being a 35 or 40 per cent solution of U. S. Pharmacopœia specifications. The water used for the necessary dilution of the formaldehyde must be added to the formaldehyde, and not be poured upon the dry permanganate crystals or added after the formaldehyde and permanganate have been mixed. Except by adding the

[1] Experimental work done by Dr. H. W. Hill, Minneapolis.

correct amount of water to the formaldehyde, before the mixture with the potassium permanganate is made, the gas will not be evolved properly, nor the disinfection be a success. Hot water is best. The ebullition of the mixture is sudden and violent, bubbling up to a height of about nine inches. There may be some droplets which are thrown outward about eighteen inches. Whatever this liquid touches it stains. The pail which is used in the disinfection becomes stained and cannot be cleaned. When used the pail should rest in a metal wash-tub, upon a piece of tin, a tin waiter or in a basin. Several thicknesses of newspapers should cover the floor around the pail to a distance of three feet to prevent the staining of the floor. If a smaller size of the ordinary pail or bucket is used much of the liquid may boil over the edge, and its staining of the floor should be guarded against. It is advisable to use a large ten-quart, galvanized iron pail in the work, as one of this size retains all the boiling liquid. The formaldehyde gas will not damage furniture or fabrics.

Potassium permanganate crystals when exposed to the air for several weeks or months lose their iridescence and become of a uniform brown color. These crystals are of poor quality and do not cause a proper ebullition of the formaldehyde gas. Fresh crystals and those not exposed to air and dampness should be used. If the chemicals used are good and the method is properly carried out there should remain in the fumigating pail only a dry crystalline powder.

A substitution method, to replace the employment of permanganate, is reported[1] by Dixon, as follows:

Formaldehyde, 40% solution.........	1 pint
Add sulphuric acid, commercial.......	1½ fluid ounces
Glycerin..........................	1½ fluid ounces
Pour mixture over sodium dichromate crystals........................	10 ounces

[1] Dr. Samuel G. Dixon: *Jour. Am. Med. Assn.*, Sept. 19, 1914.

These proportions for 1000 cubic feet capacity of room to be fumigated.

The crystals should be spread out in a thin layer over the bottom of a vessel having ten times the capacity of the ingredients used. The evolution of gas is very rapid.

The wet sheet method of formaldehyde disinfection is simple and probably just as effective as the permanganate method. In it the full strength formaldehyde is sprinkled upon an open sheet which is hung up or draped over chairs in the room to be fumigated. When properly done one pint of formaldehyde may be sprinkled upon an open sheet without any of the liquid dripping upon the floor and without the chairs being in contact with the wet parts of the sheet. The formaldehyde may be sprinkled from a bottle or a child's toy watering-pot.

The spraying of formaldehyde by a hand spray is effective but too tedious and exposes the operator to the fumes so long that it should not be used for room disinfection. It may be used for local use as for the spraying of school pencils or other accessories, or for disinfecting pillows or other bedding or towels which have been temporarily used by tuberculous or other infectious persons. But these goods should be enclosed in closets or other small containers when fumigated.

Formaldehyde fumigation kills bacteria but not animal or other plant life. Some live house plants may be damaged by it. It will not kill household insect pests, except a few mosquitoes. Sulphur will kill insects, but burning sulphur should not be used as a bactericide as it bleaches and destroys fabrics and is inert except in the presence of much moisture.

Deodorants. — Deodorants are usually a menace — at times they become a danger. Wherever obnoxious odors arise their cause should be sought and eliminated. Deodorants do not destroy odors nor remove their cause. They only mask odors, covering all evidence of the presence

of the objectionable or dangerous cause of the odors. The nuisance, not the odor, should be abated. Deodorants do not check putrefaction, nor are they disinfectant.

EPIDEMIOLOGY

In the control of communicable diseases the two big factors are the isolation of the infectious individual and the location and effective control of all susceptible contacts. The chief work of the epidemiologists is to prevent persons spreading disease. For effectual work the persons who become exposed and who are apt later to spread infection should be apprehended, warned and also isolated from other susceptibles before the damage is done. It is as important thoroughly to guard against disease being spread from the given case of disease on hand, as to prevent further infection being spread from the original source. The discovery, study and control of the source of infection, the isolation of the person throughout the period of infectivity, and the effective control of susceptible persons who become exposed to the infectious individual constitute the science of epidemiology. The epidemiologist is more than a registrar and works in conjunction with the state registrar, who, when efficient, is a statistician.

When a case of contagious disease is reported to the health officer he seeks the source of infection and obtains the names of all persons who have come in contact with the contagious child since the beginning of the disease. The individual who was the source of infection may be visited and names of susceptible contacts be obtained from him. These persons may be visited, and warned or isolated. The health officer also obtains from the patient the names of all other members of the family who have not previously had the disease, and the names of all other children who were exposed since the beginning of the infectivity. The susceptible contacts are excluded from schools at the end of the approximate minimum incubation period, ac-

cording to the number of days as given in the accompanying table.

EXCLUSION PERIODS FOR EXPOSED SCHOOL CHILDREN

Chickenpox	One week after exposure exclude for two weeks.
Diphtheria	Immediately exclude and until giving negative cultures.
Measles	Seven days after exposure exclude for two weeks.
Mumps	Ten days after exposure exclude for ten days.
Scarlet fever	Immediately exclude for three weeks, as a minimum.
Smallpox	Immediately exclude for three weeks, unless vaccinated.
Whooping cough	Seven days after exposure exclude for two weeks.

These exclusion periods should be counted to begin from the first known or suspected exposure and to terminate at the given time after the date of the last exposure. When children are notified to report to school, after being excluded because of some contagious disease, they should be ordered to report while classes are in session and not to make their first appearance at the beginning of the morning or afternoon session when all the other children are in the school yard and in danger of exposure to a contagious disease. By reporting during school hours these suspicious children can go at once to the principal for examination without possibly endangering a large number of children. The children, returning from their exclusions, are seen by the principal who can isolate them in unoccupied rooms to await the visit of the school physician, or who examines them at once and sends back to their homes all children showing any signs of the diseases, fever, rash, sore throat, cough, or lassitude. The families are advised what to expect as early symptoms of the disease and are warned to isolate the cases of disease and to report them.

Follow-up work is done in the homes known to contain susceptible children who have been exposed to contagious diseases. Other unreported cases, the so-called missed

cases, may be discovered by tracking up school absentees, and following reports obtained from children or adults.

Spot Maps. — Spot maps are used for locating cases of disease, or for other geographical purposes. Cases may be indicated by ink spots or by using colored-headed pins. Cases under quarantine may be located by pins, the spots to be colored in ink after removal of the pin at the raising of quarantine. By locating the cases of disease upon maps much epidemiological information may be obtained. The grouping of cases is readily seen. The relation of the groups to each other or to existing social, industrial or sanitary conditions may be noted. The mapped cases may indicate the relations the outbreak may have with localities congested with various nationalities, with the character of the houses used, with school or playground centers, with milk supplies, with separate public or private water supplies, with existing yard toilets, with mosquito or fly breeding areas, or with frequented business or amusement centers. Cases of disease should be spotted upon maps for determining the location of the source of infection, that measures may be adopted to prevent future cases and deaths. Where a disproportionate number of cases of disease, or of births or deaths, occurs in a certain mapped locality the influencing factors should be determined.

ANTHRAX

Anthrax or charbon is a disease of animals easily transmitted to man. It is primarily a disease of horses and cattle, sheep and other cloven-hoofed animals. It is caused by the anthrax bacillus. Anthrax infection of the skin is called malignant pustule, of the respiratory tract, woolsorter's disease. Anthrax is a disease of very rapid development and high fatality. The bacilli exist in great numbers in the blood of the infected animal and may easily infect a person through a scratch or abrasion of the skin, or be swallowed. Persons working in making brushes

of bristles or those working with raw wool, received from countries where anthrax is prevalent, may contract the disease. These animal products received from infected districts should be disinfected by steam or hot, dry air, or by formaldehyde.

Animals when infected with anthrax should be quickly destroyed and the carcasses disinfected as described for animals with glanders. Especial care should be exercised in the disinfecting because anthrax bacilli are very resistant to disinfectants.

CEREBROSPINAL MENINGITIS

Cerebrospinal meningitis or spotted fever occurs in epidemic or sporadic forms. The epidemics are usually small and localized. The disease may infect persons of any age, but in most epidemics young children are the most frequent sufferers. March, April and May are the months when the greatest number of both epidemic and sporadic cases appear.

The cause of epidemic cerebrospinal meningitis is the meningococcus, specifically termed the diplococcus intracellularis meningitidis. Other forms of meningitis, but similar in symptomatology, may be caused by the pneumococcus, streptococcus mucosus, influenza bacillus, tubercle bacillus, primarily, and as secondary infections by the streptococcus pyogenes, staphylococcus, typhoid bacillus and other organisms.

In doubtful cases lumbar puncture may be performed for diagnostic purposes. A spinal fluid showing an increase in the white blood cells with an increase in globulin or albumen indicates an inflammatory condition, and in sporadic cases may be regarded as probably indicating either a tubercular meningitis, a meningococcic meningitis or a poliomyelitis. If a froth forms upon shaking the fluid in the test tube there is probably an increase in albumen. An increase of the white blood cells is suggested by a cloudy or ground-glass

appearance of the liquid if viewed by a strong reflected light. The spinal fluid is then examined microscopically for the specific organisms.

The mortality of cerebrospinal meningitis is about 90 per cent when no anti-meningococcic serum is given, and about 30 per cent following the use of serum.

The quarantine of a case of meningitis should be rigid. The apparently healthy children should be separated from the infected, but be isolated for two weeks or longer.

Disinfection of the apartments occupied by a case of meningitis seems perhaps unnecessary as the organism is reported to be readily killed by drying, also by sunshine and freezing.

CHICKENPOX

Chickenpox or varicella is most common between the ages of one and six years. It is comparatively rare in adults, although a few cases may be seen. A case of varicella is infectious from the beginning of symptoms to the time when the last crust drops off the body. The specific cause of the disease has not been isolated, nor is the exact mode of transference known. There is little danger of its being carried by a third person. One attack usually immunizes the individual. The disease has absolutely no relation to smallpox or to the vaccination which is the prophylactic against smallpox.

Every case of chickenpox should be reported to the local health officer, who should inspect the case for the purpose of confirming or correcting the diagnosis. To the health officer or to a representative of the state board of health should be given legal authority to decide upon all diagnoses of infectious diseases, especially respecting chickenpox and smallpox, and to exercise the necessary control.

A house containing a case of chickenpox should be placarded as a public warning. There are occasional cases of the disease of great severity, causing considerable suffering

and much objectionable scarring. Isolation of the person with chickenpox from susceptible children is advisable from the beginning of symptoms and should be maintained until the last crust has come off the lesions. Those children who show fresh skin lesions or who still retain the crusts of the dried vesicles should be excluded from school. Children who have not had the disease and are exposed to the infection should be excluded from school after one week following the exposure. Children who are exposed to the disease or who live in infected families, and who have had the disease, may attend school.

Disinfection following varicella is useless.

DIPHTHERIA

Diphtheria, formerly one of the most fatal of diseases, is being conquered through the use of antitoxin. But owing to the existence of many unrecognized cases and carriers, and because many cases do not receive antitoxin sufficiently early or in large enough doses, diphtheria still remains one of the serious diseases of children. Its high tide of sickness is in early school life, but the greatest mortality is during infancy. People in middle adult life are rarely attacked. Diphtheria is more prevalent in the northern than in the southern states. About one-fourth of the people who are closely exposed to diphtheria cases contract the disease, 26.9 per cent among 21,377 exposed persons having contracted it in Providence from 1889 to 1907, according to Dr. Charles V. Chapin.

The cause of diphtheria is the Klebs-Loeffler bacillus.

Great variation exists in the types of diphtheria, from the most severe cases, fatal in a few hours, to the types so mild as to be recognized with difficulty. The common conception that the disease exists only with the appearance of a dirty, grayish-white membrane must be discarded. Cases of diphtheria may be infected with highly virulent bacilli, yet without showing visible signs of the disease. These

cases, especially of nasal and laryngeal infection, are the ones most difficult to detect and to cure.

Diphtheria is not air-borne. Transmission occurs through direct contact. Casual acquaintances cannot be regarded as very dangerous transmitters. The disease is propagated by intimate contact and short and direct transference of the bacilli from one throat to another. The danger of the disease sweeping through a hotel or apartment house is little. Extension from one family to another living in the same house rarely, if ever, takes place except among people who are evidently very careless or have little control over their children. Chapin has shown[1] that of 8802 children in 3171 families living in the same houses with diphtheria cases only 3.7 per cent contracted the disease. The opportunity for cross infection to occur between different families using the same doorway is negligible. There is practically no danger of non-infected children of an infected family transmitting the disease to other children with whom they play. The danger is only by direct contact with the people who harbor the bacilli within their own throats. Well children belonging to an infected family should be separated from those having diphtheria, and, one week later, after having shown a negative culture may be returned to school.

Although the transmission occurs by direct contact probably in nearly every case, the diphtheria bacilli may be conveyed through the agency of lead pencils, drinking cups, candy, handkerchiefs, public towels, spoons, toys, dirty hands or kissing — by any agent which gets into the mouth of persons having the bacilli within their throats. The careless use of clinical thermometers, tongue depressors or other instruments used in the nose or throat may produce transmission. Careless coughing, sneezing or spitting over books or other surfaces which children touch, or upon

[1] Dr. Chas. V. Chapin: *Rep. Department of Health, Providence, R. I.*, 1907.

food, clothing, tables or bedding may further increase the numbers of diphtheria cases to a very slight extent. Milk occasionally becomes the agent of transmission. When due to a milk supply the infection may come from bottles infected in the houses of customers, or the infection may exist in some person who handles the milk. In thirty-six milk-borne epidemics reported by Kober thirteen were due to cases of disease existing on the dairy farms.

Hospitalization. — Hospitalization of diphtheria cases should be encouraged. Much can be accomplished by general education and by the medical inspectors who visit the houses. The benefits derived from hospital care far outweigh any slight danger of mixed infections.

Hospital Effect upon Diphtheria in Philadelphia, 1912

Deaths among the cases removed to the Municipal Hospital	8.98%
Deaths among the cases treated at home	18.98%
Secondary cases among families of cases sent to the hospital	3.82%
Secondary cases among families of cases treated at home	19.75%

Antitoxin. — Antitoxin is the preeminent cure of diphtheria. Its use has saved thousands of lives. It should be given as early as possible; a delay of a day or longer markedly increases the danger of a fatal termination. During an outbreak of diphtheria of high mortality or severe infection, the high virulence of the existing infection should be publicly announced that physicians may practically meet this condition which they cannot readily diagnose clinically.

Immunizing doses of antitoxin may be given to those people who are intimately exposed to virulent diphtheria and who are so situated that symptoms of secondary in-

fection may not be discovered in time to give curative doses of antitoxin the first day of the disease. Braun reports[1] that of 2218 children who had been exposed and were then immunized, 1.62 per cent developed diphtheria, with 4 deaths. In non-treated families he reports that 35 per cent contracted the disease. The danger from antiphylaxis is so much less than the danger from fatal diphtheria that it should not be considered, except under certain rare conditions. Antitoxin in any amounts should not be given to children with asthma, hay fever, or severe acute or chronic bronchitis. Wallace also includes[2] those having unstable vasomotor symptoms, and those in whom odors of animals cause coryza and dyspnea. In these conditions a small dose of antitoxin may cause an immediate antiphylactic death. Children with these conditions who contract diphtheria should not be treated with antitoxin but may receive nasal and faucial sprays of emulsions of lactic acid bacilli for their therapeutic effect.

Shick Test. — The Shick test apparently will reveal those who are susceptible to diphtheria and may be adopted for selecting those exposed people to whom prophylactic doses of antitoxin should be given. The Shick test is performed as follows: The skin upon the flexor surface of the forearm is sterilized by tincture of iodine, and receives from a sterile hypodermic syringe, just beneath the superficial layer, 0.1 c.c. of fresh standard diphtheria toxin which contains $\frac{1}{50}$ of the minimum lethal dose for a 250-gm. guinea-pig. A small, white bleb-like elevation appears immediately and persists for several minutes. The results of the test are available at the end of twenty-four hours. If normal antitoxin is absent, or present in the person only in very small amounts, insufficient to grant immunity, a positive reaction appears as a constantly increasing, circumscribed area of redness and induration from 10 to 25 mm.

[1] Braun: *Journal American Medical Association*, June 4, 1914.

[2] Wallace: *Medical Record*, Jan. 7, 1911.

in diameter, reaching its maximum in forty-eight hours. It persists for about a week, leaving a brownish discoloration with superficial scaling and a central infiltration. Positive reactions indicate that the person is susceptible to diphtheria, though intensity of reaction varies with individuals. Persons giving a positive reaction to Shick should be immunized with antitoxin if definitely exposed to diphtheria.

Behring Vaccination. — The Behring vaccination against diphtheria may prove a useful artificial immunization to be used during outbreaks and for those people especially exposed to infection. It perhaps may grant permanent immunity, but will have no effect over diphtheria carriers.

Control. — The control of diphtheria must lie in the early discovery of those people capable of transmitting virulent bacilli and in their effective isolation. Upon the appearance of a case care should be taken to locate any person who may have been the source of the infection. A person may be found who was in intimate contact with the patient the previous week, and may prove to have had the disease recently or prove to be a carrier. Other cases appearing in the neighborhood may be found to have had some direct or indirect contact with the first known case. There may be found some other person or object with which all the people who subsequently became infected with diphtheria had had some relation. This other person may have been a new acquaintance, a playmate, school member, teacher, nurse, laundress, cook, storekeeper or neighbor. This person may have had the disease recently, or by having been brought in contact with some diphtheria case, had become a temporary carrier.

Culturing. — The most dependable and accurate diagnosis of diphtheria is that made by the microscopic examination of the bacterial cultures of the nose and throat of the person. Many cases of diphtheria cannot be diagnosed by any other means. In culturing people for diphtheria dependence should not be placed in a culture from the tonsils alone.

Cultures should be made also from the nasal fossæ. Cultures from the throat should be made from the deep crypts of the tonsils and by firm wiping of the supra-tonsillar recesses. Cultures should not be attempted within twelve hours following the use of any local applications, nor immediately following feeding or drinking.

Where culture tubes are not available for practicing physicians, reliable results may be obtained if the doctor makes his own cotton swab and sends it in a bottle to the laboratory. Absorbent cotton is not as useful for swabs as non-absorbent. The applicator of the swab should preferably be of white pine or other non-resinous soft wood, or of aluminum wire. I found that applicator sticks made of resinous yellow pine, used by physicians in the South, apparently had a destructive influence upon the bacilli. Copper and iron wire when used for swabs will kill some of the bacilli, giving misleading results from the examination.

Laboratory examinations should be made immediately upon receipt of the swab or culture. By this immediate examination a few cases showing typical Klebs-Loeffler bacilli may be detected, and a positive diagnosis be made without delay. Because of the value of this immediate smear examination, I prefer that the cotton swabs should be forwarded with the culture, either left in the culture tube or enclosed in another sterile tube. If the physician sends to the laboratory a swab, without himself inoculating a culture tube, the laboratory man makes a culture from the swab before making the smear examination. Cultures should be examined after incubating for six to twelve hours. Those specimens received before noon are incubated and examined late in the afternoon, in order that reports may be forwarded the same evening. They are then, if doubtful or negative, reexamined in the morning. Examinations for release are made after 12 or 24 hours incubation.

Reports sent to the physicians should indicate whether the cultures found were pure or mixed, and, in mixed cul-

tures, the contaminating organism be indicated if important. Diphtheroid throats when containing mixed cultures of staphylococci are apt to give a better prognosis. Laboratory records, by including the types of diphtheria bacilli found, when followed up with comparisons of infectivity and mortality, may assist in determining the significance of the various types of Klebs-Loeffler bacilli. It seems of little practical value to report the Wesbrook types to the physicians until more is learned concerning them. A revision of the Wesbrook-Wilson-McDaniel classification of the types of Klebs-Loeffler bacilli is desirable, since many organisms are difficult to classify according to it.

Quarantine. — The quarantine in diphtheria should be strict, providing complete isolation of the patient. The patient should be kept apart from the rest of the family, none but the nurse, mother and physician being admitted. When the mother enters the room she should slip on some extra outside washable garment which will completely envelop her clothing. After leaving the patient she should remove this covering and thoroughly wash her hands. All eating utensils — plates, spoons, tumblers, drinking tubes and napkins — should be sterilized by immersion in boiling water at the door of the sick-room. The hanging of wet sheets at the door of the sick-room is useless except as a warning that entrance is forbidden. The use of burning candles, air sprays, pans of disinfectants and other methods of creating odors, with the expectation that they will destroy supposed air contagion, is a useless, obnoxious humbug. A printed card tacked on the doorway will serve to prevent people entering the room. The windows of the sick-room should be screened, and all flies which enter be killed by baited traps. The patient should be provided with Japanese paper napkins or muslin handkerchiefs which are removed from the room only after being enclosed in paper bags or newspapers, and immediately burnt.

Milkmen should not be permitted to leave bottled milk at

a house quarantined for diphtheria. The milk should be poured by the milkman into a pitcher or preserve jar outside the door of the house, the milkman not touching the pitcher. Placards requiring this caution by the milkman should be tacked in conspicuous places outside the house.

Release from quarantine should be permitted only after obtaining two successive negative cultures from both the nose and throat of the patient and after one negative culture from the other members of the household and also two negatives from the acting nurse. Where possible, the second release culture of the patient should be made by a representative of the local or state health department. Cultures made for release of the patient should not be made within three days of each other. In rural districts where all cultures must be made by practicing physicians, the termination of quarantine after such culturing gives better results and is more dependable than a release after an arbitrary time limit. Single cultures should be made of all contacts, if possible.

Disinfection following diphtheria may possibly be abolished. Disinfection is useless unless it has been shown that all members of the family are free from diphtheria bacilli. Disinfection of rooms not actually occupied by the patient is useless. No confidence should be placed in disinfection without first making cultures from the throats of all members of the household. The people, rather than the house, are to be feared. In Providence, in testing the efficacy of fumigation, during a period covering six years, Chapin found that among 1492 families having diphtheria there were recurrences after disinfection in 1.67 per cent; without disinfection in 860 families there were recurrences of the disease in 1.74 per cent.

Diphtheria Carriers. — A diphtheria carrier is one who retains within the nose or throat diphtheria bacilli without having any symptoms of an infection. A so-called case of diphtheria harbors virulent Klebs-Loeffler bacilli with the

production of constitutional or local symptoms, however mild. A carrier may possess active virulent bacilli or may reveal only attenuated non-virulent organisms. A person should not be classed as a carrier unless morphologically typical Klebs-Loeffler bacilli have been found by culture from the nose, pharynx or tonsils. A large number of healthy people will show diphtheria bacilli within their throats, but these are practically all avirulent and of no importance in the control of the disease. When people under observation persist in giving positive cultures in spite of treatment, tests for virulence should be made, when possible. Isolation and treatment of people possessing only non-virulent diphtheria bacilli is unnecessary and useless.

The practical control of diphtheria carriers is of great importance. Under the present stage of public health advancement this can best be accomplished by isolation, placarding and spraying. Antitoxin should not be given to diphtheria carriers, since they have no toxin to be neutralized. The carriers should be excluded from schools and other gatherings if other cases of clinical diphtheria have been known to have some connection with them. These suspiciously virulent cases should be isolated until proved actually free from bacilli.

The removal of enlarged tonsils[1] as a means to overcome the carrying of diphtheria bacilli is meeting with success.

The spraying of diphtheria carriers with live cultures of staphylococci was first suggested by Musgrave. The theory of benefit was founded upon the assumption that the growing staphylococci would destroy the less resistant diphtheria bacilli, without creating harmful effects upon the person treated. Numerous investigators have used staphylococcic sprays without harmful results, but in numerous instances harmful effects have been noted from the use of staphylo-

[1] Dr. S. A. Friedberg: *Jour. Am. Med. Assoc.*, Mar. 11, 1916, p. 810. Dr. Henry Albert: *Jour. Am. Med. Assoc.*, Sept. 27, 1913, p. 1027.

cocci. Since under certain conditions staphylococci become pathogenic they should be avoided in diphtheria sprays if safer organisms are available. Wood recommended,[1] after personal trials, the adoption of cultures of lactic acid bacilli for use in diphtheria sprays, and suggested that ordinary sour milk be used as nasal and throat douches for both treatment and prophylaxis for distant rural cases and elsewhere where antitoxin and other efficient measures cannot be had immediately. Michael, Wessinger, Nicholson and Hogan, and others reported promising results from lactic acid bacilli but other later investigators report adversely. Accepting the few trials, sprays of lactic acid bacilli may be used therapeutically for the treatment of diphtheria in cases having asthma, hay fever and severe bronchitis, where the use of antitoxin may produce antiphylaxis. In the few instances where employed therapeutically lactic acid bacilli have caused a rapid disappearance of the diphtheritic membrane, symptoms and bacilli.

In spraying, the frequency of employment depends, as with antitoxin, upon the severity of the case, the dosage or concentration, and the effect produced. When placed in the atomizer the suspension should not be too highly diluted. I used a suspension which was opaque in a half-inch test-tube when placed over printed matter. This rather high concentration was used as a spray once daily. It was not a bought stock culture, but isolated from sour milk. More dilute suspensions require more frequent application. If the spray is uncomfortably sour it may be sweetened with sugar. Since these lactic acid bacilli are normally found in wholesome sour milk they apparently can do no harm to the patient. Sour milk douches may be made by the patient sniffing into the nose and drinking, or gargling, ordinary sour milk. The milk may be dropped into the nose or throat from an eyedropper or be applied by a cotton swab. Marked benefit has resulted from its

[1] Dr. H. B. Wood: *Jour. Am. Med. Assoc.*, Aug. 9, 1913.

use in the few cases reported. Kaolin powder insufflated into the nose and throat has been of benefit.

The use of bacterial sprays and sour milk douches should not supplant antitoxin when the latter may, can and should be given. Neither do the sprays give promise of being used prophylactically for immunization. There is no rational excuse for using antitoxin as a spray. Antiseptics used as sprays or washes are perhaps no more reliable nor far reaching than the bacterial sprays.

GLANDERS

Glanders or farcy is a highly contagious and very fatal disease of horses, mules and other animals and is readily communicated to man. It is caused by the Bacillus mallei. The germs are present in the mouth and nose of infected animals and through their discharges harness, feed boxes, stalls and the hands of the persons working with the horses easily become infected.

All cases of glanders in man or stock should be promptly reported to the veterinary, health and agricultural authorities.

Control of glanders is obtained by early diagnosis of all infected animals, using the serum test when needed; by an immediate destruction of all infected animals and complete disinfection of the premises. Every animal known to be infected should immediately be killed. Cremation is preferable for the carcass, but it should be complete and all remaining parts buried. When any animals are cremated special care should be taken that dogs will have no access in any way by which they may become infected. All harness, parts of wagons, stalls, watering trough, buckets, and other places which could have been infected by the animal having glanders must be thoroughly disinfected. Destruction by burning is best. Where this is not practical the disinfection may be done by dipping into or wiping with a 10 per cent solution of formaldehyde

(formaldehyde 1 ounce, water 3 quarts), or 8 per cent carbolic acid (carbolic acid, 1 ounce, thoroughly dissolved and stirred into a gallon of water), or a chloride of lime solution (one teaspoonful of fresh chloride of lime completely dissolved in a gallon of water). Metal parts should not be left to soak long in the chloride of lime. Articles of harness and similar articles of value should be rinsed off with water after being dipped or wiped over with the disinfecting solution. All these disinfecting solutions are advisedly given in great strength. The articles to be disinfected should not be touched by the bare hands; they may be handled by using rubber gloves, pincers or other convenience.

HOOKWORM DISEASE

Hookworm disease is essentially the one filth disease. It is a result of primitive living, a stamp of lack of civilization. It comes from polluted ground and is propagated by the savage custom of depositing the dejecta promiscuously in convenient places. Hence its eradication depends as much upon an education of the children to form the proper habits of life as it does upon getting adults to build tight privies. The detection and cure of all cases is also of paramount importance.

Hookworm disease is caused by the *Necator americanus*, a small, white, thread-like worm, about half an inch in length. The hookworm disease encountered in the Old World is caused by a similar intestinal parasite, the *Ancylostoma duodenale*. Besides these parasites other intestinal infestations are frequently encountered in the warmer regions of the United States.

The eggs of the hookworm, as of similar intestinal parasites, are passed from the patient in his dejecta. These microscopic eggs develop into minute embryos within a few days in warm weather. If the person with hookworm disease deposits his stools upon the open ground or into

overflowing surface privies the live embryos may be trod upon by a barefooted person. The polluted mud adheres to the feet and from this caked mud the *Necator* embryos rapidly burrow into the skin causing the eczematous condition with its intense itching known as toe-itch, dew-poison or ground-itch.

Rural sanitation is the great need in hookworm latitudes. Since most of the hookworm infestation occurs upon isolated farms these are the places which need the greatest sanitary reformation. In the inspection work of the Rockefeller Sanitary Commission in 501 counties in the Southern states, of 189,586 rural homes visited 95,988 were found to have no privy of any kind.

Control. — The safe disposal of all human excreta in hookworm countries is a problem to be solved in conquering hookworm disease. This implies the making of improvements in the systems used by every individual and every community. Cities and towns should extend, improve or adopt safe public sewerage. Small villages which are not able to install sewerage systems should legally require and compel every house to be supplied with a safe, fly-tight privy or cesspool which cannot pollute the surface of the ground nor any water supply. The town then should adopt some effective method of cleaning the private toilets, by licensed or public scavengers, with deep burial of the night-soil in waste land. Where a town uses the privy system the people may be compelled to reconstruct the toilets to accommodate metal cans. The scavanger arrives at necessary times, removes the full can and covers it in his wagon, leaves a clean empty can in the privy, and collecting a load of cans drives out of town. The night-soil is then buried in deep pits or in ploughed furrows, or it may be mixed with ashes. It should not be used as fertilizer, nor be deposited where it may wash into water-courses, be accessible to animals, nor be deposited near houses or public roads. Dogs and other lower animals can become infested

SOUTHERN RURAL SCHOOL
EVERY PERSON INFESTED WITH HOOKWORM DISEASE

SUBJECTS OF HOOKWORM DISEASE SHOWING PUFFY FACES AND ENLARGED ABDOMEN

with hookworm disease and serve as transmitters of it, therefore all night-soil should be kept out of the reach of animals.

The sewage disposal system recommended for individual houses should be commensurate with the intelligence and financial ability of the owner. No one system should be universally recommended. It is unwise to attempt to compel or induce a man to build a system which obviously is beyond his ability to construct and maintain. If he has sufficient intelligence and resources to build and keep in good condition a sanitary privy with tubs, such a system should be recommended. If he is able to construct a subsoil drainage system with house toilets he should be asked to adopt one. If, however, he has not the money or the intelligence to build a simple box privy this system should not be recommended, but he should be encouraged to use a dug pit with a plain board seat, or even with a seat consisting of a pole resting upon two forked sticks. The dug pit will check soil pollution, if not fly infection, and is an improvement over surface pollution in hookworm regions. If the pit is sunk in clay or is otherwise made water tight, it may be kept filled with water to exclude flies. An advance over the open pit would be one covered with a box, with a board lid. Civilization demands that this toilet be screened or enclosed within walls to insure privacy. These box privies should be built tight against fly infection and soil pollution. The box privy may be placed over a pit or be supplied with tight box receptacles or metal tubs to collect the dejecta. Water added to the tub will prevent fly infection but will increase the odors. Dry earth or ashes used as a covering will check the odors but will not prevent fly infection. People cannot be depended upon to use lime for preventing fly infection. The use of lime to keep out the flies is of no value unless the dejecta be completely covered. This is expensive since it requires a large quantity of the lime. The best way to maintain a box

privy is to cover the dejecta daily with dry earth to check odors, and prevent fly infection by having tightly built privies, with hinged lids which cannot remain open, and by having all openings covered with muslin or mosquito netting.

The wearing of good shoes will avail much in the stamping out of hookworm disease, but owing to the prohibitive expense in many districts little gain can be expected along this line.

The free treatment of those hookworm cases who are unable to seek the services of private physicians is a public duty since it constitutes one of the principal methods of overcoming hookworm disease. The treatment may be given through established hospitals to which the cases are publicly urged to apply. In the hospital treatment the people are admitted in the afternoon, stay one night, receiving their treatment and return to their homes the next day as a new delegation arrives for treatment. The other method, better adapted for the treatment of large members of hookworm subjects, is that which was usually adopted in the hookworm campaign — the administration of doses of thymol to the patients through temporary dispensaries. These dispensaries were stationed in vacant stores and porches, in barns or tents or in any convenient available place. A previous educational campaign with extensive bill-posting notified the public of the opening of the dispensary. The people were invited to call at stated times, each suspect bringing a small fresh specimen of the bowel movement. The fecal specimen was examined microscopically at the dispensary, and the required dosage of thymol given with printed directions. The salts-thymol treatment was taken at home by the patient who returned in a week for the next supply of medicine. Complete card catalogues of all cases and doses were kept in the dispensary.

MALARIA

Malaria is a very common disease in warm regions but owing to frequent mistakes in diagnosis the approximate prevalence of the disease cannot be estimated. More microscopic work is needed in establishing diagnoses. There are three or four varieties of malaria occurring in this country, each caused by a specific plasmodium. According to the Blanchard classification these are:

Quartan malaria caused by *Plasmodium malariæ*,

Tertian malaria caused by *Plasmodium vivax* (Grassi),

Tertian æstivo-autumnal malaria caused by *Plasmodium falciparum* (Welch).

Craig has added to this list the *Plasmodium falciparum quotidianum* as the cause of a quotidian form of æstivo-autumnal malaria.

The tertian malaria is the most prevalent form.

Malaria is transmitted only through the bite of the female *Anopheles* mosquito. There is no such thing as miasmatic malaria, or malaria due to dampness, night air, fog or swamps. Wherever malaria exists there are *Anopheles* mosquitoes, although they may not easily be found. Neither does malaria always prevail where this particular genus of mosquito is found. There are many small sections where *Anopheles* mosquitoes are especially numerous, but where there is no malaria. This condition exists because no person with the malaria organisms within his blood has gone into those regions and given the mosquitoes an opportunity to become infested, or the climate may be too cold for the development of the plasmodium within the body of the mosquito.

The female *Anopheles* mosquito is nocturnal in habits, commencing her flight about dusk and continuing until nearly midnight. Apparently the greatest number are on the wing between sundown and darkness, therefore it is during these hours that the greatest precaution against the mosquitoes should be taken. The farmer who does late

chores, the workman who works late into the evening, the people who spend the summer evenings outdoors or on the porch, and the householders who keep their unscreened windows open in the evening are the ones especially exposed to *Anopheles* bites and to malaria. For avoiding mosquitoes these people may use fumigants applied to exposed skin surfaces. Their clothing should be of sufficient thickness or of a hard tight weave to prevent puncturing by the mosquito; light colored clothing attracts fewer mosquitoes than dark. One of the most satisfactory fumigants which will repel the attacks of the mosquitoes is oil of citronella. Crushed naphthaline moth-balls dissolved in a small amount of sweet oil or alcohol are also quite efficacious.

Anti-malaria Work. — In fighting malaria there are four principal avenues for work in this order of their importance:

1. The discovery and cure of every person harboring the parasites.

2. The discovery and obliteration of mosquito-breeding places.

3. The effective screening of houses, especially those occupied by plasmodia-carriers.

4. The use of quinine as a prophylactic for the well.

Surveys. — Malaria surveys are essential in malarial regions. These surveys, as carried out in the Southern states by Von Ezdorf, of the U. S. Public Health Service, are for the purpose of determining the prevalence of the disease and what local measures will be most effective for its eradication. Data are collected from local physicians of the amount of malaria encountered in their practice. Schools and other institutions are visited and microscopic examinations are made of the blood of the attendants. The relative number of cases showing suspicious histories or chronic splenic enlargement is determined. Search is made for breeding places, and the local activities taken against mosquitoes, the amount of house screening and the care given the carriers of parasites are noted. Through public

meetings and individual instruction the people are given the essential facts of the effective methods of conquering the disease. All malaria carriers, discovered during the making of the survey, should be housed, thoroughly screened and be given medical treatment. Mosquito breeding is fought and houses screened. The public must be impressed with the necessity of following these measures to the utmost limit, especially that one most important measure, the proper treatment of all mosquito parasite carriers.

An intensive malaria campaign may be conducted similarly to the hookworm work. Temporarily established and well-advertised dispensaries may be used. The local inhabitants are subjected to the necessary microscopic and other examinations, and are given the needed doses of encapsulated quinine with printed directions. These people should also be shown specimens of adult mosquitoes and of live larvæ of different species, and be told in what places search should be made to discover breeding places, and how the mosquito breeding may be checked.

The treatment of the human carriers of malaria is the most essential prophylaxis against widespread malaria infection, considering the standpoint of economy, of cheapness, of effectiveness and of social efficiency. Man is the propagator of malaria; man is the chief host and the disseminator.

Mosquito breeding should be prevented as far as is practicable and possible. This subject, an important one for the economy, comfort and safety of many communities, will receive practical consideration in the chapter upon insects.

Screening. — Screening is an important prophylactic against malaria. Houses in regions where mosquitoes abound should be effectively screened to keep out the ordinary pestiferous insects and to prevent malaria. It is most important to screen beds and houses occupied by people who are harboring malaria parasites in their blood. Bed

canopies or mosquito-bars should be made of fine bobbinet, without a side slit and hung on a frame. The length and breadth of the canopy should be slightly smaller than the corresponding dimensions of the bed. Since mosquitoes are apt to rest during the day underneath the bed and to fly out at night, the mosquitto netting should not extend beyond the side of the bed, but should rest upon the bed, or, preferably, be tucked beneath the mattress. In screening a house all apertures should be carefully guarded. Screen doors and window screens, especially, should fit, not leaving cracks along the sides or bottom. The screening should be kept in good repair. All doorways and windows should be netted on the outside, the window nets covering the entire window. Chimneys leading from unused open fireplaces should be blocked by tacking netting, muslin or cotton cloth completely over the opening. Chimneys should not be blocked by being stuffed with paper, for fear of future fire. All cracks under the eaves and in the walls and floors should be filled. Screen doors should be tight. If the doors tend to sag they should be braced up in place, by having a board strip nailed from the lower hinge corner to the upper opposite corner while the door is closed in the doorway. Or a wire brace may be used by stretching a heavy wire from the upper hinge corner to the lower opposite or knob side. One end of the wire is nailed in place and the other end, twisted around a nail head, is drawn taut while the nail is driven into the screen door while closed in the doorway.

The size of the mesh of the wire screen should be sufficiently small to prevent passage of all mosquitoes. The screen usually found in the stores will permit many mosquitoes to readily pass through. The wire screen to use for screening houses is No. 16, or that having 16 meshes per inch. No. 14 will prevent *Culex* gaining entrance. For southern regions No. 18 mesh is necessary to check all *Stegomyia*. The 18-mesh wire is used in the Canal Zone.

Copper wire screen is the most durable and desirable but is expensive. Where tinned-iron screen is used it should be painted at the end of the first season. All black-wire screening should be freshly painted immediately after being first put up. Black-iron netting will not last one season without becoming rusty unless freshly painted. If carefully painted on both sides when new the black-iron wire is very satisfactory and cheap, and will last several seasons. The windows of bedrooms are those most necessary to screen. The upper rooms in a house should be selected for bedrooms, the mosquitoes being more numerous near the ground. Vines and bushes do not breed mosquitoes but offer protection from wind. Where mosquito breeding cannot be prevented a clearing away of all bushes and vines will decrease the mosquito supply. Mosquitoes seek the lee of the house and protection under eaves and porch flooring. Within the house they rest in dark places during the day, in closets, behind pictures, in draperies, under furniture and in dark corners; therefore these places should be inspected and the mosquitoes killed. It is especially necessary to kill all mosquitoes gaining entrance to any house in which is a person sick with malaria.

The prophylactic use of quinine in regions where malaria is especially prevalent is frequently desirable. This constitutes a daily dose of quinine given to all well persons who may be exposed to the mosquitoes. The daily dose given is usually five grains. The Army of Occupation at Vera Cruz in 1914 was given daily doses of three grains each.

MEASLES

Measles is a disease which has not received its due consideration by health boards or by those who formulate or enforce the laws. The general public is too prone to accept it as a necessary condition. Although transmissible three or four days before the rash appears the disease can largely be controlled and its wholesale invasion of schools prevented.

Statistics of measles, as of some other contagious diseases, as usually received and published are so incomplete that various local conditions must be considered before judging the approximate prevalence of the disease. When but few cases of the disease are reported for a community it indicates that there are but few cases present, or that there are many cases but the physicians either see or report but few of them. It should be the endeavor of the health officer to determine the true cause of the scarcity of reports, and to obtain complete statistics. Public notices requesting reports of known or suspected cases will assist, but the principal method of obtaining complete reports is by the tedious work of persistently tracking and watching susceptible contacts. In one school class outbreak of 17 cases coming from one exposure there were 22 secondary cases in the families of these children. In another class outbreak there were 19 children attacked at one exposure, and 25 secondary cases developed in their homes. In investigating the prevalence of measles account should be taken of the social conditions of the districts involved, for among the poor and those of foreign extraction there are apt to be more children having closer association with others, and therefore more secondary cases. Also with these peoples there will be fewer calls upon doctors and fewer reports of cases.

The fatality varies considerably under different conditions, the chief predisposing factors being infancy, depressed vitality and low social or economic conditions of living. The disease is most fatal in the first year of life, the prognosis of recovery increasing rapidly after the third year. Bad housing, over-crowding in homes and dense population in cities, insufficient food, squalor and dirt all usually mean a higher attack rate and a higher death rate.

The infectivity of measles is transmitted by the discharge from the throat principally, as during the early cough and sneeze, and it also comes from any discharge

which may come from the nose, eyes or ears. The small scales of desquamated skin have nothing to do with transmitting the disease, therefore the scaling is entirely disregarded when terminating the isolation of the patient or the exclusion from school. The absence of cough, and of red or watery eyes, the disappearance of a red, patchy or sore throat or fauces, and the freedom from coryza, nasal secretion or ear discharge mark the period when the child ceases to be infectious. When each one of these has cleared up, the child has ceased to be a danger and may return to school and to other associates. It has been amply demonstrated that measles is not carried in clothing.

Control. — The control of the individual with measles is simple. The infective child should be kept under strict isolation from the beginning of symptoms until after all signs of infectivity have passed. All children in the same family, and living within the same household, should be excluded from school, Sunday school, parks, picnics, playgrounds, parties and other premises where they would expose other children, unless they have had measles. Children of the same household who have had measles may attend school. The writer knows of no evidence indicating the existence of measles carriers. It is unnecessary to destroy any school property, library books, bedding or clothing used by a person having measles.

A placard should be displayed at both the front and rear entrances of the residence of the case of measles, preventing the entrance of all susceptible children.

The strict early isolation of every case of measles is imperative. A case of measles becomes infectious and able to transmit the disease three or four days before the rash begins to appear. Nearly every susceptible child who is exposed will contract measles, the case rate being about 85 per cent. Adults who have not had the disease are less susceptible than children, and the attack is less severe with them. One attack grants immunity almost invariably;

but people should not confound German measles with measles, believing one disease offers protection against the other. Every child who is known to be susceptible to measles, not having had it previously, and who is known to have been exposed to a case, should be excluded from schools and child gatherings and isolated, after seven days have elapsed after the known first exposure. This isolation will be within the time of the usual minimum incubation period and will prevent the early transmission which occurs before diagnosis is made. If the exposure was intimate the symptoms of the disease are almost certain to begin about the ninth to twelfth day. This control of the early case checks one or two days of exposure toward others and the resulting transmission of the disease, which would probably occur if isolation were not begun until the appearance of the rash. In checking outbreaks of measles it is advisable for the health officer to placard the houses of the known exposed susceptible children on the seventh day, if the parents' consent can be obtained, even although no symptoms have appeared. The placards prevent thoughtless women taking their children into the homes of those who are just beginning to be infectious and dangerous.

Disinfection after the termination of a case of measles is useless.

MUMPS

Mumps is a serious disease. Any disease which by its complications may cause sterilization of the individual should be considered as a serious disease worthy of much attention from the standpoint of prevention and control. The disease is much more serious after puberty than in young children. Owing to the damaging effect upon the race and because of its great infectivity, mumps should be included among the reportable diseases.

The majority of children of school age will contract mumps when exposed. Susceptible children should be

excluded from school ten days after exposure unless symptoms of soreness or swelling develop earlier.

The cause of mumps, the Lavaran-Catrin diplococcus, usually infects one or both parotid glands. Any salivary gland may become involved, and cases of involvement of the submaxillary glands without infection of the parotids are not uncommon. In an outbreak the solitary involvement of the submaxillaries may commonly be found. Gradenigs describes mumps showing bilateral deafness without parotitis. A second attack after a unilateral infection may occur. When examining children, especially in schools, for possible infective cases, it is important to note these variations. For purposes of practical school control unilateral mumps is regarded as granting immunity.

The infectivity is transmitted through direct contact, is greatest in the early stages of the disease and rapidly declines after the swellings subside. Isolation should last from the beginning of symptoms until the end of infectivity. Until more is known of the termination of infectivity it is advisable to continue isolation until the disappearance of symptoms.

Disinfection following mumps is useless.

POLIOMYELITIS

Epidemic poliomyelitis or infantile paralysis is an infectious, communicable disease, of low infectivity, rapid development, high fatality, and obscure epidemiology.

The majority of cases occurs in children but persons of any age may acquire the disease. The young are much more susceptible. In rural sections the higher age groups are involved, in the cities a greater proportion of children. The attack rate is greater in rural than in urban communities. Environment shows no obvious or necessary causative connection. Cases may appear epidemically or sporadically. In an epidemic the cases appear as simultaneous groups and the wave soon sweeps onward. The epi-

demics are self-limiting, quickly burning themselves out. It has been noted, however, that a year may be skipped and be followed by another outbreak in the original neighborhood. In this and in the distant appearance of cases and outbreaks so far remote that they seem to be disconnected, poliomyelitis bears quite a strong resemblance to rabies.

It is apparently a summer disease, the cases decreasing in number as the summer temperature declines. The disease is rare in the colored race; blonds appear to be more commonly attacked than are brunettes. The outbreaks have been in northern climes and have involved to a greater extent those states and communities which are populated from northern Europe. These are all epidemiological points to be considered in the anticipation of an outbreak and its control.

Poliomyelitis carriers are believed to exist, and to be a potent factor in the dissemination of the disease. They may be recovered abortive cases. It is quite possible that the distemper which attacks dogs and other animals is caused by the same organism. A dog with distemper should be isolated or killed, and no child should be allowed to associate with it.

The causative factor of poliomyelitis was regarded as a filterable virus but the infective organism may have been discovered recently. In its etiology poliomyelitis closely resembles hydrophobia, the latter disease producing a filterable virus, a minute organism and an involution form in the central nervous substance.

In 1913 Flexner and Noguchi[1] cultivated and demonstrated microscopically a small filterable micro-organism with which they produced poliomyelitis in monkeys. Rosenau, Towne and Wheeler[2] isolated from persons with

[1] Drs. Simon Flexner and H. Noguchi: *Journ. Experimental Medicine*, 1913, XVIII, 461.

[2] Drs. E. C. Rosenau, E. B. Towne and G. W. Wheeler: *Journ. Am. Med. Assn.*, Oct. 21, 1916, p. 1202.

poliomyelitis a streptococcus which appeared to be identical with the organisms described by Flexner and Noguchi and perhaps is the specific micro-organism which produces poliomyelitis, the experimental work apparently agreeing with Koch's postulates. Nuzum and Herzog[1] isolated the same organism. The coccus found by Geirsvold and by Harbitz and Scheel during the Norway epidemic may have been the same organism, and also the organism isolated by Dr. Herbert Fox of the Pennsylvania State Department of Health in 1907.

The transmission of poliomyelitis is from the secretions of the nose and mouth. This was proved by the researches of Lansteiner and Popper in Germany, of Kling, Petterson and Wernstedt in Sweden, and of Flexner and Noguchi in this country. The infective organism may exist in the bowel discharges of infected persons. The infection is received through the mouth, tonsils and nose.

Secondary cases occur in the same family with comparative rarity, but often enough to warrant insistence upon isolation and other preventive measures. It is believed that the virus becomes readily transmitted and that but few persons becoming infected develop the disease.

The incubation period appears to be usually between 4 and 8 days, but may be as short as two days, or longer than two weeks. The incubation in the experimental cases of Rosenau, Towne and Wheeler was from three to five days; in guinea pigs, 9 or 12 days (Roemer).

The mortality varies from 10 to 50 per cent.

Control. — The patient should be isolated. The windows and doors should be well screened and all insects entering the room be killed. Nobody should be admitted to the patient's room except the nurse, the physician and health officer. Household pets must be kept out of the room. There should be no dry sweeping done while the

[1] Drs. J. W. Nuzum and M. Herzog: *Journ. Am. Med. Assn.*, Oct. 21, 1916.

patient is sick. The well children from an infected house may be allowed out of doors but should be kept by themselves and away from large groups of other children. These and other contacts should be watched for two weeks.

The house should be placarded and, as an added precaution, it seems advisable to state that no milk bottles should be left at the house.

The minimum period of isolation is now placed at six weeks although three or four may later prove sufficient. Hospitalization is desirable.

In case of death burial should be prompt and the funeral strictly private.

RABIES

Hydrophobia or rabies is a definite infectious, communicable disease. It is fortunately rare among human beings. The exact causative organism has not been isolated or definitely identified, but the Negri bodies found in the central nervous system of an animal having rabies are proof of the disease.

The mortality from human cases of rabies is nearly 100 per cent in persons not receiving the Pasteur treatment. The Pasteur treatment has reduced the mortality to about $\frac{1}{2}$ per cent. It is estimated that about 20 per cent of all persons bitten by rabid dogs contract the disease.

All cases of hydrophobia in animals and also in persons should be reported immediately to the health authorities.

The incubation period is between 12 and probably 100 days or more, usually being from three to six weeks.

Many animals are susceptible to hydrophobia but the degree of susceptibility and that of toxicity varies. About 15 per cent of the animals bitten by rabid dogs contract the disease, but from the bites of rabid wolves 60 to 80 per cent become infected. Wolves, dogs, foxes, hogs, cows, horses, ground squirrels, chickens and cats seem to be susceptible in about this order. The disease is widely

disseminated by the wanderings of dogs. An outbreak begins and quickly subsides. Its next appearance is in a remote region, giving the appearance of the existence of carrier cases among dogs.

A dog developing symptoms of rabies becomes restless, is inclined to keep moving or running at large, is easily disturbed or annoyed and quickly shows his resentment by barking or biting. If an apparent attack is made upon him, as with a stick, he retaliates by striking back and biting. He quickly develops a slowly increasing paralysis of the pharyngeal muscles, which prevents his swallowing. The difficulty in swallowing is first noticed in drinking. The dog does not actually froth at the mouth, but after attempting to drink, the water drips from his mouth, and later there is more or less continuous dripping of saliva from the corners of the mouth. This saliva may apparently contain air bubbles, from the action of the jaw, cheeks and tongue. Later it may be streaked with blood. The inability to swallow soon extends to solid foods and the hunger and thirst become frightfully intense. This leads to frequent attempts at biting. An attempt at drinking intensifies the discomfort and augments the so-called madness. It will be realized that both the common names of the disease are founded upon misconceptions of the actual symptoms, although in the human cases there is an apparent maniacal fear. Paralysis soon develops, usually beginning in the hind legs as a distinct weakness. The legs soon become encumbrances and are dragged, and soon the legs are unable to bear the weight of the animal. The animal sinks to the ground, becoming progressively worse and dying.

Animals suspected of having rabies should not be killed at once but should be chained or otherwise securely fastened and kept strictly confined for at least two weeks. Their feeding should not be forgotten. If at the end of two weeks no symptoms of rabies have appeared it may safely be

concluded the dogs are not infected. The only excuse for killing a dog immediately after he has bitten is in case the animal is in the furious stage or when attempts to capture it alive will subject the persons to the danger of being bitten. When the dog is running away and cannot be caught it should be shot.

If the supposed mad dog has bitten or scratched anybody the head of the dog should be sent to a competent pathologist to be examined for Negri bodies. The head is removed, entirely wrapped in paper and packed upon ice. If possible, it should be enclosed in a tin box and the lid soldered on or held securely by surgical adhesive plaster to prevent leaking. The brain should not be removed from the skull, but the entire head be sent to the laboratory. A telephone or telegraph message should precede the shipment. If the material cannot be delivered within two hours to the laboratory it must be shipped with enough ice to insure its keeping ice cold until examined, allowance for Sunday intervening in transit being made. After removing and wrapping the head the hands and tools should be carefully sterilized and scrubbed. The entire head of the dog should be carefully removed without getting the saliva upon the hands. No person who has any scratches, abrasions or other sore places upon the hands should attempt to remove the head of the rabid dog, or to have anything to do with the dog at any time, for fear of becoming infected.

The places where the dog has been kept during its illness and where the head was removed for the laboratory must be carefully disinfected. It is especially important that the ground, utensils and chain upon which the sick dog dropped his saliva should be disinfected. The ground may be disinfected by covering it with three feet of straw which is set on fire. All bedding and old scraps of food and bones must be burnt. Water troughs or tins may be disinfected by placing them in the fire.

The results of the laboratory examination should be reported by telegraph, and if positive, Pasteur treatment should begin at once.

Prevention. — The prevention of hydrophobia lies in the effective quarantine and muzzling of all dogs in involved sections. The example of England in entirely eradicating the disease by quarantine, inspection and muzzling might be duplicated by other countries. The wire muzzle which prevents biting is best. A leather strap around the jaws is uncomfortable and does not prevent the dog biting. Laws requiring muzzling should specify strong wire muzzles.

Where there is an outbreak of rabies among animals everybody living in the section for miles around should immediately be notified by telephone, newspapers, public posters, or by other means as a warning of the impending danger. They should be encouraged to keep all animals penned up for two or three weeks so that it will be impossible for strange dogs to molest or bite the stock. All animals, as horses, which must be taken to other places for work should be carefully guarded against dogs. Leather or canvas leggings for horses would be a benefit. All dogs of the neighborhood, whether sick or well, should be required to be securely chained day and night for at least four weeks, under penalty of being killed. Stray dogs showing peculiar symptoms or a tendency to bite should be shot. These are the effective measures for limiting and checking an outbreak of rabies.

SCARLET FEVER

Scarlet fever, or scarlatina, is one of the most serious diseases of childhood. It is most prevalent in the Spring, the scarlatinous tendency decreasing with the advent of warm weather. Warm climates and warm countries are comparatively free from the diseases. Scarlatina attacks by preference the Caucasians; Negroes and those living in warm countries are less susceptible. Of the Europeans

coming to this country especially those from the blond or lighter races and more northern countries may be expected to suffer from this disease. Hence in a city composed largely of these northern and whiter peoples more rigid control should be exercised over existing cases, and more widespread epidemics may be expected than when the population represents southern Europe. Knowing these influences of racial susceptibility and temperature effects the health officer is better able to grade his work in reference to scarlet fever.

Not everybody is susceptible to scarlet fever. Chapin has shown that about one-third of those exposed to scarlet fever contract the disease. Of 21,029 people exposed during twenty years in Providence, 32.94 per cent were attacked. Some people possess a natural immunity, but after many exposures some of these people may contract the disease. There is apparently a family predisposition to scarlet fever; especially is this true in regard to the fatal cases. If two cases appear in the same family especial care must be taken to protect the others as they are probably more susceptible than the average person. When several children of the same family become infected and a fatality results a similar outcome may be looked for in the other cases. A recurrence of scarlet fever is rather rare, there being but few authentic instances recorded, although Chapin reports 175 secondary cases among 1439 exposed children who were reported as having previously had scarlet fever.

The transmission of scarlet fever occurs by the specific organisms being discharged from the nasal or oral cavities. The particles of desquamating skin have nothing to do in the transference of the disease. If bedding or clothing has contained the infectious matter, carrying it to non-immune people, it is because these goods were contaminated by oral secretion rather than by the pieces of shed skin. A case of scarlet fever ceases to be infectious when there are no signs or symptoms referable to the gastro-respiratory

tract and when the infecting organisms have left these cavities or have lost their virulence. In the presence of any outbreak, any child showing a scarlet redness of the throat, and especially when showing a "strawberry" tongue or prodromal symptoms, should be isolated at once, and search made for a beginning rash. Since the specific cause of scarlet fever is not definitely known a cultural method of diagnosing the infectiousness of scarlet fever is not yet possible. Numerous organisms have been convicted of causing scarlatina, but none has yet (1916) received universal recognition as being the exciting cause. A great need is the absolute identification of the causative organism and the invention of a method for rapid and easy culturing or easy microscopic identification through specific tinctorial or morphologic characteristics.

The bacterial prophylaxis of scarlet fever is still in the experimental stage. Bacterins of staphylococcus aureus have shown some promising results. A lactic acid bacillus throat spray is worth trying for both prophylactic and curative treatments.

Control. — In the control of the individual case strict isolation is essential. This isolation should be within a municipal hospital. This will mean a sojourn in the hospital for about a month; but some cases may be dismissed from quarantine within two weeks.

In subduing an outbreak rapidity of action and enforcement of strict isolation are essential. The work must be pushed with the utmost vigor. Each known case is visited and all known contacts learned. All these contacts should be quarantined and visited daily, beginning immediately because of the possible incubation period of only a few hours. Any person who is not known to have had scarlet fever is strictly isolated at the earliest appearance of any suspicious signs and the homes placarded. Each assembly of children, schools and Sunday schools should be reached at once and all such places closed immediately or inspected

frequently. It may be necessary to close theaters and other amusement places. All school rooms are visited daily and upon the appearance of any case a closure of the schools is warranted, unless the closing of school became necessary at the beginning. Under certain conditions, discussed under school hygiene, school closure is not advised.

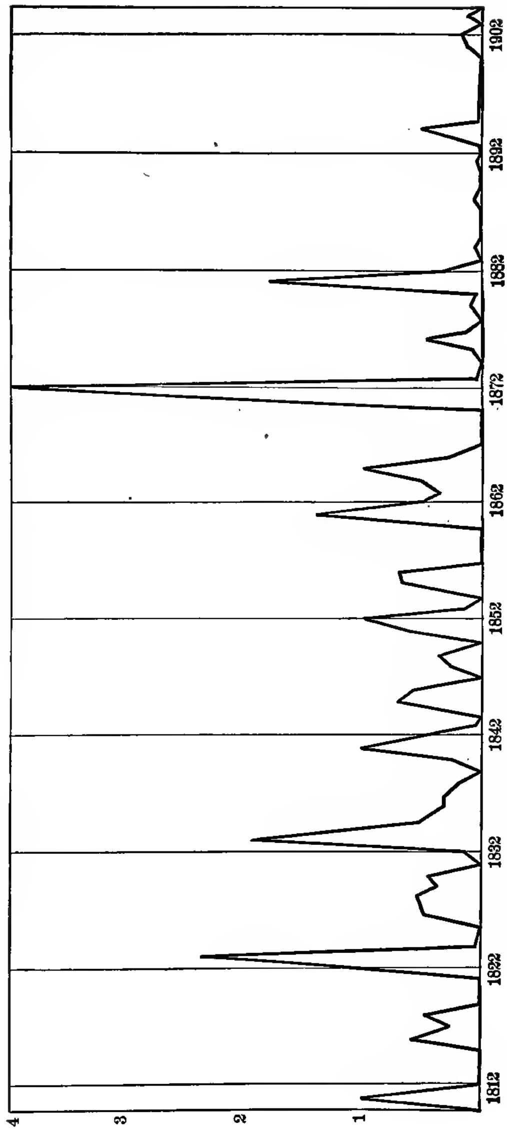
Milk-borne scarlet fever is not unknown. Every outbreak should be investigated to determine the possibility of a milk supply being the transmitting agent.

Placards should be placed upon all premises harboring scarlet fever cases. The milk bottle placard should be posted to prevent bottles of milk being left at the house and becoming contaminated.

Formaldehyde disinfection after scarlet fever may be abolished, or should be done only after the health officer is reasonably certain that all inmates of the house are free from infection. As shown by Chapin, disinfection is really of little avail. The sooner the health officer abandons such methods of defense, including disinfection, and works mainly in the offensive the sooner will he obliterate disease. As with many other diseases, the danger of human carriers of scarlet fever is much greater than any possible danger arising from infected clothing or rooms. People rather than fomites transmit the diseases; therefore not disinfection but isolation is the need.

SMALLPOX

Smallpox exists at present principally in a mild form, which appears to be more of a hybrid nature than a recent alteration, by vaccination, of the severe type. The mild form may be from an attenuated organism which has long been transplanted through unfavorable, vaccinated soils. A few instances of severe infections occur, but it is probable that the mild cannot develop into nor revert to the malignant disease, except through many generations of transmission. The malignant form also exists in isolated regions.



DECENNIAL WAVE IN SMALLPOX DEATH RATE IN PHILADELPHIA

The transmission of smallpox occurs almost always directly from some one who has the disease. With the malignant form of the disease there were a few known instances where transmission was believed to have occurred through fomites, as bedding or clothing, and an occasional conveyance by a third party. But these dangers are rather slight and need little consideration in the control of the disease, except with a malignant case of the disease. The probability of the transmission of the mild form of the disease taking place through inanimate objects or by a third party is so extremely remote it may be disregarded in the control of smallpox.

Fumigation will not stamp out smallpox. Fumigation of the apartment, bedding and clothing used by a malignant case of smallpox is helpful. It may be used after the existence of a severe attack of the mild form of the infection. Following a very light case of the mild form of variola fumigation is probably of little use. Dependence should be placed in vaccination, not in fumigation.

Statistical curves demonstrate that smallpox visitations come every ten years with more or less regularity. In the United States the outbreaks of variola have been ushered in about those decennial periods beginning with the year 1, and have been waning or disappearing about four years later; that is, existing from 1901 to 1904, inclusive, and during the corresponding years of the other decades. In some instances there have been mid-decennium rises. Aside from being constantly on watch for the early appearance of contagious diseases, it is desirable to know when to anticipate the probable outbreak or increase in the morbidity rates. This regularity of appearance is more marked with smallpox than with the other diseases, and assists the health officials to adopt special preparations.

Quarantine. — The control of smallpox must be accomplished through vaccination, combined with the quarantining of those who have the disease. The usual method

of house control is to enforce vaccination upon all exposed persons and to place all under absolute quarantine. The Minnesota method is to placard the quarantined house with a warning sign, admitting to the house those who have been vaccinated. The inmates of the house are given the choice of immediate vaccination and release after the development of the vaccination vesicle, or, refusing vaccination, these persons are placed under absolute quarantine for three weeks. Freshly vaccinated people should not be released until at least a week following vaccination, in order to determine the success of the vaccination and to avoid the escape of secondary cases of smallpox.

Quarantine of a malignant case of smallpox should be absolute, every member of the family and household being included. The quarantine may be removed following disinfection, being done after all crusts have dropped off from all lesions of the last case appearing within the house. Nobody except physicians, nurses and ministers should be permitted to enter or leave the premises holding malignant cases of smallpox.

During the period of quarantine, warning signs in large type should be displayed in conspicuous places at both the front and rear doors of the building. With mild smallpox the card should be as a warning, permitting only those who are protected by recent vaccination to enter.

Vaccination. — Compulsory vaccination should be established by state and municipal law and enforced by health officials. Successful vaccination should be made obligatory on all persons admitted to schools and colleges, to public institutions and houses, and in the army, navy, marine and merchantmen services; it should be required of all doctors, nurses, hospital employees, ministers and undertakers. As an added measure of safety and efficiency the heads of large industrial and commercial establishments should require their employees to show good scars of successful vaccination.

In performing a vaccination the only sterilization of the skin that is required for the average person is a brisk rubbing for two minutes, using soap, water and a clean towel or sterile gauze. For very dirty people ether or alcohol may be applied after the scrubbing. Antiseptics applied to the skin are apt to remain and destroy the vaccine. They should not be used. Even the use of alcohol is not advised.

MILD SMALLPOX; NEVER VACCINATED. HER DAUGHTER WAS VACCINATED AND PROTECTED

The skin should be perfectly dry before the vaccination is done. Vaccination should be made preferably upon the left arm. Of the various methods of producing the skin abrasion the writer prefers scratching done with a sterilized needle. The needle is less painful than a glass or bone scraper, or a scalpel, and less startling than the Von Pirquet drill. The abraided area should be about a quarter of an inch square. The scratching should be superficial to avoid drawing blood. I prefer glycerinized vaccine, as

the vaccine which is dried upon points must be moistened and rubbed off and is apt to remain on the vaccine point. Also, this rubbing when done by inexperienced men may produce infection or yield harmful bleeding. The glycerinized vaccine is expressed from the capillary glass tubes by a small rubber bulb, never by blowing with the lips. Vaccine tubes made of wax are convenient, as the vaccine is easily expressed by squeezing the tubes, but care must be taken not to contaminate the vaccine when breaking the tube. It is preferable not to drop the vaccine upon the smooth skin, but to scarify the skin first, as the field is clear and the appearance of serum is more easily noted and bleeding avoided. The vaccine should dry upon the arm before applying any protective dressing, if possible. If it has dried, a sterile gauze held on by adhesive straps gives the best protection; if moist, a large, rigid shield may be applied for a day. Vaccination shields should not be used except for one purpose, to prevent injury and rupture of the vesicle. Vaccination shields, if worn, should be rigid and should not be perforated. Metal shields which may be sterilized by boiling or heating are best. Perforated celluloid shields on felt bases are very objectionable. Compressed paper shields may be used, after sterilizing over a match flame. Bunion plasters should not be used as shields, being much inferior to plain gauze. As soon as the vaccine has dried the shield may be removed. As soon as itching begins or a vesicle develops, a gauze or rigid shield protection should be worn to prevent traumatism and rupture of the vesicle. If the wound begins to discharge, the shield should be removed at once and an antiseptic gauze dressing applied.

Since vaccine rapidly deteriorates when warm none should be bought or used which has not been kept ice cold. Druggists and others supplying vaccine should be required to keep their stock at the coldest refrigerator temperature. Vaccine may remain potent six months or a year when

kept ice cold, but stored upon a warm shelf, or carried in the pocket, its vitality may be lost within a week. Only fresh vaccine should be used in hot weather.

Certificates of vaccination should not be given until one week following vaccination. They should show the dates

NORMAL VACCINATION ABOVE A LARGE CICATRICIAL SCAR WHICH DOES NOT DENOTE IMMUNITY

of vaccination and certification. Certificates signed within five days of vaccination are unreliable and useless.

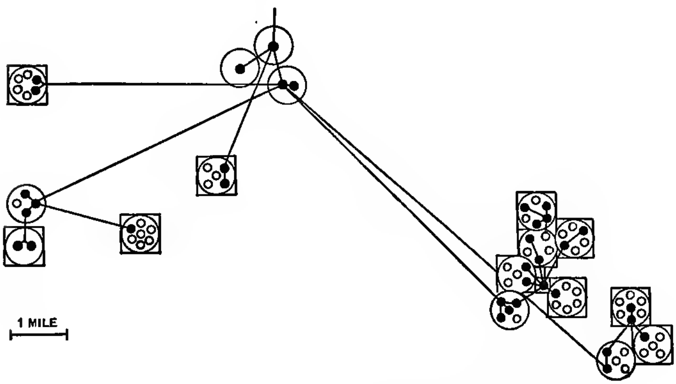
The time to vaccinate is in the early weeks of life, as soon as the infant has obtained a good foothold. If any person is exposed to smallpox, vaccination should be done

immediately, without regard to age or condition or previous vaccination. Infants have less discomfort from vaccination than older persons, they having little or no annoyance or pain from the irritated arm. Children during the period of active vaccination should be kept apart from those unvaccinated, especially those having skin eruptions, as eczema, impetigo contagiosa or other acute rashes.

A recent successful vaccination confers absolute protection against smallpox, but after a lapse of some years partial susceptibility may return. A mixed infection of the abraided skin area without the development of vaccinia should not be mistaken and be classed as a successful vaccination; it may, however, denote susceptibility, as has been suggested. Revaccination should be practiced when the original scars become indistinct or when smallpox appears in the vicinity. It cannot be declared, however, that a person having quite an indistinct scar is not immune. The safer method is to test the immunity by a repeated vaccination with a vaccine of known potency. The theory of Dyer seems tenable. He maintains that the primary vaccination may not grant complete immunity. To overcome this remaining partial susceptibility Dyer revaccinates at the end of two weeks. If this shows a successful " take " or even a partial reaction there still remains a partial susceptibility. Therefore, revaccination should be repeated every two weeks until no reaction results. The acquired immunity which is granted by this repeated vaccination of Dyer should be permanent throughout life. This theory is feasible and the method needs further trial or adoption.

Control. — The epidemiologic activities require rapid and energetic work to discover the source of the cases in hand and to reach all people exposed by the previous or present cases. A careful history of all activities, travels and contacts should be obtained, getting the names and addresses of all people with whom the case came in contact,

with dates. These people are found and examined. If unvaccinated they should be vaccinated and quarantined for the two weeks following the date of their meeting the patient, or for ten days following vaccination. A record should be obtained of all places visited by the patient, and if stores were visited while he was in the infectious stage, descriptions of the people met in the stores should also be obtained. These persons are found and vaccinated. After the period of incubation of smallpox has passed these people should again be examined for the presence of a successful vaccination or of smallpox. The source of the infection is discovered after a similar intensive questioning and inspection, the names and addresses of all contacts during the second previous week being obtained. This is readily done with rural cases. By following up the contacts early cases may be intercepted before they have an opportunity of spreading infection.



RURAL OUTBREAK OF SMALLPOX IN MINNESOTA

Large circles: Households involved, showing distances.
Squared circles: Placarded households, no transmission.
Black dots: Smallpox cases, none ever vaccinated.
Small circles: Other members of same families; vaccinated, protected.
Small square: Rural school where teacher had smallpox.

The accompanying diagram illustrates a rural outbreak as traced by the writer in Olmsted County, Minnesota, and demonstrates the effect of quarantining and placarding, and the protective influence of vaccination. Of the thirty-four persons who contracted smallpox not one had ever been vaccinated. All of the vaccinated persons remained well. The infection was spread by persons visiting or teaching school while having pustules upon their faces.

TRACHOMA

The highly virulent, blinding eye disease, trachoma, may be encountered in communities which are segregated and tend to have little communication with the outside world. Such people are apt to live primitive lives without the adoption of the principles of hygiene as applied to the ways of living. Trachoma, therefore, is common among Indian tribes and other primitive races. It has been discovered prevalent among people living as isolated communities within the mountains. Where such communities are known to exist they should be inspected that any persons with trachoma may be discovered, instructed and treated. Permanent mining camps or other densely populated, isolated colonies composed of peoples from eastern Europe also should be investigated to the same end.

The prevention of trachoma must be founded on the adoption of the individual towel and the individual handkerchief. A person may live under the best hygienic conditions and still be very negligent in his personal habits, from ignorance or carelessness. Education of the people to adopt correct personal hygiene both in family and individual habits is essential. Young children learn first by imitation and later by precept, therefore the example set by their parents and caretakers should be as spontaneous habits of personal hygiene. Flies may possibly transmit trachoma and must be persistently fought in trachomatous

families and districts. The needed eradication of dangerous flies and the details of personal cleanliness with the ways of transmission and avoidance of trachoma should be given special emphasis by the school teachers. General isolation of the cases should be adopted where practical, at least contact with others should be limited. Every case of sore or inflamed eyes in trachomatous districts should receive attention, as some may be trachoma.

The period of infectivity of trachoma has not been definitely determined. The acutely inflamed eye may be contagious, but the eye may possibly be infectious without outward signs of disease.[1] Cases with exuberant granulations may be dangerous, due to the trachomatous granule rupturing and extending its contents. This secretion may be seropurulent or so slight as to escape notice in a hasty examination.

TUBERCULOSIS

Tuberculosis is the great scourge of the civilized race. It causes more deaths than does any other disease. Considering its mortality, curability and preventability the question of tuberculosis is paramount to nearly all other community health demands. It forms a local question and needs local solution. Each community, each village, city and county should take active steps to determine the amount of local involvement, the modes of induction and transmission and the methods which may be adopted for the control and eradication of the great white plague within the specific locality. Where cities or counties are not able to cope with the disease state aid should be forthcoming.

The cause of tuberculosis lies in the infective tuberculous, and the transmission is probably more immediate and direct than is commonly believed. It is known that

[1] W. W. King, Surgeon, U. S. P. H. S.: *Public Health Reports*, Dec. 18, 1914.

tubercle bacilli are very resistant to moisture and to drying, to starvation and to the ranges of temperature of the weather. When, however, they are subjected to these conditions, which may be termed unnatural to their environment, they probably become more or less attenuated. Dr. R. C. Rosenberger found tubercle bacilli alive after being kept submerged in sewage a year and a half, but these bacilli were losing their virulence.

Reports of every case of tuberculosis of any part of the body should be sent to the health office. The reports should state the kind of tuberculosis, giving the parts of the body involved. They should state if tubercle bacilli are being discharged; if laboratory examinations have been made, by whom and with the results; and also give the patient's previous residences with dates, besides stating the usual statistical data. The homes of all cases of tuberculosis occurring among the foreign and poor population should be visited by nurses in search of unreported or undetected cases, and for giving needed instruction.

Environment. — Industrial tuberculosis is due to close contact and resulting infection from other workmen who have the disease, or it may be induced through the environment and hygienic conditions permitted in the industry. Exposure to dust and long hours spent in cramped positions or in unventilated rooms are the chief exponents of industrial tuberculosis. Dusty or vitiated air does not produce tuberculosis, but simply is harmful in that it prevents the person who breathes it from having normal lungs and the normal condition of the tissues which can overcome infection. The disease itself must come from another. A workman exposed to harmful dusts may escape tubercular infection but he will be liable to other pulmonary disorders, and his faculty of complete free oxygenation of the blood is interfered with to the extent that such a man does not have normal lungs, normal resistance or normal physical efficiency. Attempts to over-

come industrial dusts and bad air should be more than a consideration against tuberculosis. If in any dusty industry no cases of tuberculosis have appeared the question of controlling and decreasing the dust should not be necessarily neglected. The question of general health, comfort and efficiency should be considered everywhere where dust and bad air exist.

Dust induces tuberculosis by getting into the lungs and irritating the lung tissue, thereby lowering the resisting and recuperative powers of the tissues and permitting tubercle bacilli a better opportunity to multiply and to destroy. The dusts which have the greatest power to irritate, scratch and inflame the lung tissues are those composed of hard, sharp mineral particles. Hence, tuberculosis is most common among those who work at steel grinding, dry metal grinding and polishing, brass finishing, metal filing or chipping, stone cutting, quarrying, pottery making, hard coal mining, shell or bone button making, grindstone and emery wheel making. Vegetable and animal dusts, being soft and causing little irritation to the lungs, do not seem to be much of a factor in the production of tuberculosis. The disease is infrequent in millers, carpenters, paper makers, shoemakers, weavers, and in those who work in cotton mills, leather works, book binderies and cordage works or are exposed to other vegetable dusts. In the anti-tuberculosis campaign, all those industries which are classed as hazardous from this standpoint should be visited and energetic work done for the workmen. Dusts should be decreased by improved methods of work and should be effectively removed by ventilation systems, blowers and hoods. Talks should be given the workmen, showing them how to guard against the dangers and hazards of their employment. People with tuberculosis may be found working in the industries which are usually not condemned as being hazardous, but investigation will frequently show that these persons were exposed at other

places, that they have the peculiar family idiosyncrasy toward pulmonary infections and that their home life is not hygienic. Their living conditions need improving, rather than attention being given to their places of employment. All industrial establishments employing large numbers of people should, therefore, adopt systemic examinations of all employees that the tuberculous and other infectious persons may be discovered and transmission to fellow employees prevented.

Tuberculosis will be conquered when every case is known, isolated and controlled. To accomplish this greater efforts must be made to discover all existing cases, to have frequent examinations made of the people known to be exposed to phthisical patients in their own families, and to induce or compel the infective from subjecting others to their disease. The greatest factor in eliminating tuberculosis is education — to educate the people in regard to the conditions of living and of labor which assist the development of tuberculosis, to teach the public how the disease may be transmitted, how it may be cured and how it may be avoided. The building up of a generation of people with sound, resisting constitutions, drilled to care for themselves in living hygienic lives, will largely eliminate any disease, as tuberculosis, which makes its inroads through bad living, vitiated air, dusty workshops, insufficient food, alcohol and promiscuous close intermingling.

The tuberculous individual is an infectious public menace, hence his condition demands legalized control coupled with enforced medical supervision under the care of a licensed physician. The consumptive should be impressed with the necessity of following prescribed directions and he should be required to guard against transmitting the disease to others, being instructed in the nature of his disease, its devious modes of being transmitted and how to avoid transferring it.

Every person with open tuberculosis, who is coughing, spitting or discharging tubercle bacilli, should be considered

as dangerous and a menace. Those who are careful to use spit-cups and handkerchiefs are much less dangerous than the careless, ignorant persons, but to declare that even those who try to be careful are not more or less transmitters of infection is a dangerous assumption. The careful consumptive cannot be declared to be safe and harmless. Every person with consumption will unavoidably publicly discharge tubercle bacilli to a greater or less extent, and therefore each needs frequent or constant instruction and supervision. It is a dangerous policy to teach that the careful consumptives are harmless, as they believe themselves careful, when by their coughing, loud talking or by their always-infected hands they will convey the disease to their families. Many patients will declare they are following the doctor's directions carefully, yet they are often remiss and forgetful. Complete isolation of all cases is the surest method of preventing transmission.

Apart from the isolation and care of the sick, much can be accomplished by the health authorities by requiring proper ventilation and cleaning of public conveyances, sleeping cars, factories and stores, hotels and rooming houses, school houses and churches, dance-halls, theaters and other places of amusement.

Disinfection. — Disinfection of premises following their evacuation by people having tuberculosis is one of the minor methods of fighting the disease. The writer, however, believes that concentrated formaldehyde disinfection of infected rooms to be of much greater value with tuberculosis than with any of the other communicable diseases. Tubercle bacilli have greater resistance and viability than have the germs of other common transmissible disaeses, therefore, more danger should be expected from tuberculous rooms and more good may be expected from their disinfection. All measures of disinfection should be complete, including a thorough cleansing of the apart-

ments. When using formaldehyde disinfection at least one and a half pints of formaldehyde solution should be vaporized to each thousand cubic feet of room capacity. In heavily infected rooms two pints of formaldehyde solution are used. No reliance should be placed in any dry mixture from which formaldehyde is claimed to be evolved unless the exact amount of evolved gas is known and the above equivalent is obtained. So-called formaldehyde candles are unreliable in the dose recommended on them. Following gas disinfection of the premises, a thorough cleansing should be done. This includes a beating of all carpets, rugs and upholstered furniture. The rooms should be well dusted and all woodwork wiped off with wet cloths. The floors should be scrubbed, using hot water and soap. All draperies, mattresses, down quilts and other non-washable goods should be taken out doors and brushed, each side exposed to sunlight. Pillows used by the patients should be destroyed by burning. Washable bedding and clothing should be boiled or burned.

Dispensaries. — Dispensaries for the supervision and instruction of those persons with tuberculosis who remain at home should be provided by municipalities. They should be conveniently located in the districts in which cases of the disease are most apt to occur. For fear of cross infection they should not be located near parks, schools, theaters, stores or other places where large numbers of people collect. They should be upon the sunny side of asphalted streets to afford a maximum opportunity for sunlight disinfection. As a public health measure the dispensaries are essential, but they should be located with a view of creating the least amount of danger should careless patients apply. The dispensaries should be constructed and maintained under the most advanced hygienic conditions. The walls of the waiting rooms should be hung with illustrations and text in different languages, that all who come may profit.

District nurses are especially needed in the crusade against tuberculosis. The nurses frequently visit the homes of all infected families, giving necessary directions for the care of the patients and such needed attention to the other members of the family and their manner of living and working which will have an influence over their health. These nurses should be both official and hospital

INEXPENSIVE TUBERCULOSIS SHACK

in appointment and position, the hospital nurses working in conjunction with the social service bureau of the hospital. These latter nurses visit the homes of both the dispensary cases and of those patients admitted to the hospital. Supposedly well members of tuberculosis families should be examined in a search for incipient or unknown cases. The Von Pirquet skin test may supplement the physical and laboratory examinations.

Tuberculosis classes, as enrolled at the Hospital of the University of Pennsylvania and elsewhere, are a power for instructing the infected how to care for themselves and others. The well members of infected families should be requested to attend and the general public be invited.

Sanatoria. — Sanatorium treatment should be given both for cure and prevention, to the incipient and curable cases which need the hospitalization for their cure, and to the advanced cases which are dangerous and uncontrollable in their homes. Official isolation should be enforced upon the recalcitrant patients. When state sanatoria are used it seems advisable to treat advanced cases near their homes and not to subject them to long journeys, but the early cases show better results when sent to distant sanatoria in the same state as their homes. Indeed, Francine has found that in the Pennsylvania state work the patients prefer to go to those institutions which are distant. The custom of indiscriminately recommending cases of tuberculosis to go to resorts in the West should be checked, and no case should be recommended to go to any distant state without a careful consideration of the habits, condition and financial status of the person. People who are not well able to support themselves should not be sent West to become a drag upon the Western states, which are thereby forced to take care and support or bury the individual. These consumptives should not be told they may find employment in the West.

Houses should be provided for the indigent dying of tuberculosis. It is much more important to publicly house and care for the poor who are in the advanced stages of tuberculosis than it is to supply homes for the old and infirm persons who are not infectious. The tuberculous produce others of their kind and are public menaces; their hospitalization is a public duty and protection. To comfort the healthy aged is but a deserving philanthropy.

Preventoria are for preventing tuberculosis by the methods of building up body resistance to disease. Children born of tuberculous mothers or receiving other exposure within their homes should be sent to preventoria. These institutions should be established by state or private aid, and located at the ocean shore or in the mountains, wherever there is a maximum of sunshine, pure air and perhaps dryness. It is a medical duty to warn and protect tuberculous women. Bacon declared[1] that 32,000 tuberculous women have children every year in the United States and of them about one-third die within one year of labor. Also, of ten thousand children who die annually under five years of age, three-fourths are born of tuberculous mothers. Greater efforts should be taken to give these babies resisting, healthy bodies.

After patients leave institutions and return to their homes they should be followed up, and complete records be kept. When unable to obtain the services of physicians they should be furnished with necessary medical attendance and the assistance of visiting nurses. Their homes should be made healthful and habitable. The work these people are engaged in should receive attention that by their employment neither themselves nor others are endangered. When such patients change their residence or employment proper cognizance should be taken of their whereabouts that they may still be followed and observed, and not lost. Arrested and cured cases need no attention, except the advice to continue in their hygienic habits, and in case of a return of symptoms to seek the necessary medical attention and to notify the authorities of the institution from which they came regarding their present condition.

[1] C. S. Bacon: *Journal American Medical Association*, Sept. 6, 1913, p. 750.

TYPHOID FEVER

Typhoid fever is not due to general unsanitary conditions, but each case should be traceable to some specific agent by which the bacillus typhosus was transmitted from some person who was discharging the bacilli. Inasmuch as community cleanliness is desirable it cannot be expected that a general cleaning of streets, alleys and houses will have much effect in decreasing typhoid, unless some specific object is to be attained. In communities where typhoid abounds, or may break out, public sanitation should be developed along those special lines which are connected with the transmission of typhoid: cleanliness of yards and alleys, and of stables and cow barns to check fly breeding; screening of yard toilets and elimination of privies to prevent fly infection; household cleanliness as an educational feature of civilization to accelerate personal cleanliness and private decency; and better care in the handling of foodstuffs. The perfection of these attainments would eliminate flies, fingers and foods from their pronounced rôles in the transmission of typhoid. It should be understood that such activities as street sweeping, house dusting, room disinfection, the collection of fresh garbage and of ashes, steam laundry inspection and building inspection can have no effect upon decreasing typhoid. Nuisances should be abated, but nuisances do not produce disease, except where the nuisance creates a pollution of a water or food supply or attracts flies or other insects which may later become carriers of the germs of disease. Typhoid fever cannot come from sewer gas, ash piles, garbage or rubbish, but these objects may exist in a condition to become a nuisance.

The typhoid cases of a community are generally classed as being imported, epidemic or residual in character. The residual or endemic typhoid fever is that which is usually found to exist because of local carelessness, legislative

indifference, municipal inefficiency, community poverty or, usually, public thoughtlessness. Residual typhoid is kept in existence by lack of efficient public health work, by the public use of polluted water, by typhoid carriers, and by such inefficient medical supervision or official control as permits contact infection, fly transmission and incomplete disinfection of body discharges. All of these conditions which permit typhoid fever to exist in any community are but reflections of inefficiency or neglect of busy physicians, of health officers, of legislative bodies and of the general public in their conception of what is personal cleanliness and public duty. There is no such thing as normal typhoid. The disease existing in any amount is abnormal and preventable. I cannot agree with some others that heat, dampness or other weather conditions *per se* have any direct influence or ability to produce or maintain typhoid. Any such effect must come through the increase of flies, of travel or of carelessness of people in permitting infection to be transmitted.

Residual typhoid is that which maintains a constant appearance with seasonal fluctuations. It is usually due to water which receives continuous pollution from some city or large institution, to constant milk infection, as was experienced at Washington, or to the large number of carriers in large cities, each case of which maintains through flies, food or contact its many conscripts. The seasonal fluctuations of residual typhoid receive their increases by storms which increase water pollution, by droughts which concentrate water pollutions to become a tax upon filtration plants, by summer vegetables polluted by handling or by sewage, by increase of fly breeding, by immigration of susceptible people into the involved district, by the autumnal migration to the city of servants or others who may be carriers, and by travelers and vacationists who contract their infection away from home.

Epidemic typhoid, as herein used, refers to those cases

which occur as sudden outbreaks of the disease or as a suddenly appearing and marked increase of the usual morbidity rate. Explosive outbreaks occur as milk infections or special water or food infections, by reason of a special introduction into the food or drink of a large number of typhoid bacilli from a single source. Such a source may be a typhoid carrier, or a typhoid case, or an outbreak in a city up stream suddenly increasing the ordinary pollution of the water supply. The indicting evidence is obtained by correlating the data of the tabulated cases. Agencies which may act as common carriers to a large number of the cases are sought. If a majority of the cases have obtained a certain food or drink supply from a definite source some association with a typhoid case or carrier may be found. The milk man who supplies most of the families involved may be found to obtain his milk from a farm upon which may be found a case of typhoid or some one who has recently had the disease. The city distributor may be using polluted water at his establishment, he may have recently employed an assistant who is the cause of the outbreak; the milk man may be supplying an infected household with bottled milk, the returned empty bottles conveying the typhoid bacilli back to the dairy.

A water outbreak of typhoid may come from a case or carrier infecting a municipal water supply after the infected body discharges are washed by the rains or melting snows from the ground surface where they were deposited in a stream of the watershed. In some instances of explosive outbreaks the source has been traced to privies overhanging the stream. An outbreak of typhoid in one city may produce an outbreak in another city whose water comes from the river into which the up-stream city discharges its sewage. A municipal water supply may become suddenly polluted when a filtration plant is suspended for any reason and new water is admitted to the city mains. A city may be using deep well water, and at times of fire or

for other reasons raw river water be substituted for a short time. Carelessly calked or broken or leaking water mains laid on the bottoms of lakes or ponds, in swamps, below the water-table or near leaking sewers, cesspools or privy vaults will permit pollution to enter. Water mains laid on lake or river bottoms may be shifted by current or wave action, or be broken by boats, logs or ice. Outbreaks of typhoid have been caused by workmen employed at water-works or in laying water mains, and who have subsequently been found to be carriers. All of these conditions have produced violent outbreaks of typhoid, and each must be considered in the prevention of typhoid fever and in the investigation of outbreaks.

Imported Typhoid. — Imported typhoid is that contracted outside the jurisdiction of the community in which it becomes officially recorded. The imported cases are responsible for the great increase of typhoid cases in large cities during the summer and fall. The rise in the summer curve of typhoid for the country as a whole is probably as much due to the migration of susceptible people into infected neighborhoods, as summer resorts and recreation localities, with their resulting infections, as to the appearance of flies. Municipalities in publishing their typhoid rates should declare the total number of cases, the number of imported cases and the morbidity and mortality of the city corrected to include only those cases whose origin was within the city. Of the cases of typhoid reported in Michigan, 1891 to 1911, it was determined that 20.7 per cent originated outside the jurisdiction of the communities from which they were reported. In Philadelphia in 1912 the source of one-half the typhoid cases was determined, 16.5 per cent having originated outside of the city. In 1914 of 921 cases of typhoid fever reported in Chicago 19 per cent were determined to be imported and of these one-fourth, or 7 per cent of the whole number, were traced to infection received at summer resorts.

Reports of imported cases should be furnished the state department of health and also to the local health officer having jurisdiction over the locality where the infection was contracted, that future cases may be averted. When local authorities do not notify the health officer at the point of origin the duty should be assumed by the state epidemiologist.[1] The report sent the health officers should include the name, present address and date of onset of symptoms of the patient, together with the address and dates of residence in the locality where he is believed to have contracted the infection, including the name of the person with whom he lived. The recipient of these data should search for and eliminate the source of infection, and include this case in his own tabulated outbreak.

Imported typhoid is brought into a city by vacationists, by travelers and by those coming to the city for hospital treatment. The cases should be grouped in city health reports, according to this classification. The cases coming from resorts should be enumerated and investigated, that improvements may be made by local or state authorities at those resorts which produce typhoid fever. A publication of the number of cases coming for hospital treatment, with their mortality rates, will indicate the reputation and desirability of a city's hospitals, and serve as an index of hospital efficiency. The travelers' cases of typhoid fever include those contracted in labor or railroad camps, those contracted by traveling salesmen, soldiers and seamen, and the cases brought to the city by other persons who immigrate to the city in changing their residence or business.

Typhoid Carriers. — Typhoid carriers are those persons who, following typhoid infection, are discharging typhoid bacilli from the body, without showing any symptoms of typhoid fever. About three per cent of typhoid fever

[1] Plan of Dr. A. J. Chesley, Minnesota State Epidemiologist, who inaugurated reciprocal reporting.

cases become carriers of more or less chronicity. These people may discharge the bacilli for many years, a case of twenty years' standing being known. The carriers discharge the bacilli intermittently, some at long intervals, therefore the bacteriological detection of typhoid carriers is extremely difficult. Carriers are believed to harbor the typhoid bacilli usually in the gall-bladder. In the bacteriological examination of the gall-bladder of over 300 people who underwent gall-bladder operations Dr. A. H. Sanford isolated typhoid bacilli from five persons, all giving histories of typhoid attacks from six months to thirty years previously. Carriers very commonly discharge the bacilli from the intestines, but may discharge them only with the urine.

Epidemiology. — Epidemiological investigations of all typhoid cases are essential. By such work many sources of infection may be discovered and further development of cases be prevented. The search should be thorough and all interrogations be specific. The points of inquiry most essential are those followed in an attempt to learn any possible direct contact the patient may have had with some one who has had the disease, with a compilation of the data of other cases having direct or indirect connection with the same previous case. This connection may come through direct contact as in nursing and in living with the patient. It may come through drinking milk handled by the previous patient, or indirectly through infected milk bottles. A laundress may contract the disease by handling infected clothing, or she may carry the infection into her own family or into another household.

The kind of the epidemiological work done depends upon the character of the typhoid infection which is encountered. The resulting activity against an explosive outbreak will have little or no effect upon the imported or upon the endemic infection. Each class demands and deserves its own particular line of endeavor. The cases of typhoid

may quite readily be classed by obtaining the data as outlined upon the accompanying report blank. These reports of the individual cases should not be made by the practising physician, but by the health officer or his medical inspectors. The inspector visits the family of the patient immediately after the physician at the laboratory reports the case. If on the face of the report the evidence does not point toward infection having been obtained outside the local jurisdiction, the case may be judged to have originated within the community and is handled accordingly.

INVESTIGATION BLANK FOR TYPHOID FEVER CASE

1. Case No. Name Address
2. Age Sex Single, married, widowed Nationality
3. Date of first symptoms Definite date of onset
4. Widal reaction present? When? Date of previous attack of typhoid
5. Residence when taken sick
   From To
6. Residence during previous two mos.
   From To
7. Under treatment at
   If hospital give name From To
8. Character of residence: Private house, boarding house, hotel, flat, basement, store
9. Kind of store or business connected with house or family
   Address
10. No. occupants of house Names of previous typhoid patients
    When?
11. Names and business of those employed Where?
12. Names of those vaccinated against typhoid
13. Occupation of patient
    Specific duties Where From To
14. New comers in household within these months Who had typhoid? When?
15. Servants' names Addresses
16. Had typhoid when? Connection with others having typhoid?

17. Disposal of sewage: public or private sewer, privy, cesspool; number of ft. from well?
18. How much is house screened? Flies; few, many, swarms. Flies in sick room? Other insects?
19. Sanitary condition of house Yard
20. Where are flies breeding near-by? How is manure kept?
21. Absence from city within previous thirty days: From To
    Where From To
    " " "
22. Name and address of person visited
23. Known cases in vicinity of place visited Source of water used
24. Steamers traveled on When
25. Bathing: River, creek, pond, lake, bath house Where?
26. Source of drinking water
27. Source of ice supply Source raw vegetables Bakery
28. Where food taken within thirty days
29. Milk used as beverage? Is milk pasteurized? Source ice cream
30. Name and address of milkman
31. Raw oysters eaten? Source Lettuce? Celery? Strawberries?
32. Has patient been associated with persons having or suspected of having had typhoid? When? Where? How? Dates of their illness, from to
33. Are stools disinfected? How?
34. Is urine disinfected? How?
35. How are stools disposed of? Urine?
36. Other precautions taken Who vaccinated?
37. Name of attending physician Address
38. Date of first call When was diagnosis given family? Case reported by When?
39. Who is attending nurse? Nurse trained? Who cooks for family?
40. Orders given by inspector
41. Printed directions left? Where are placards posted?
42. Date of inspection (Signed) Medical Inspector.

Source of Typhoid. — The sources of typhoid infection probably occur in the following order of frequency: polluted water, typhoid carriers, milk contaminated directly by carriers or cases on the dairy farm or by indirect infection from patrons ill with the disease, contact infection, through careless nursing, fly transmission, oyster pollution, and foods contaminated by dirty hands or by human sewage and eaten uncooked. In Pennsylvania an investigation by the Department of Health of 135 typhoid outbreaks during nine years showed that 123 were due to polluted water, 7 were milk-borne and in 5 outbreaks flies or contaminated foods were held responsible.

Wells upon farms are not always involved in producing typhoid, and their unjust condemnation by physicians or health officers may work a hardship upon the farmer and not decrease the infection. After the condemnation of one suspected well, cases continued to appear, having come from a neighbor who was a carrier and made butter for sale. In another instance I investigated, a health officer had needlessly ordered the well to be resunk five times within a radius of twenty feet, neglecting to discover and condemn a washerwoman who was the carrier in the case. Such instances are common, and merely show the necessity of epidemiological work being carried out with all rural typhoid cases.

Fly infection is probably a source of typhoid transmission. House flies receive their infection from typhoid patients at various depots between the patient's bedside and the final disposal of the patient's body discharges. The physician and the health officer, and also the acting nurse and family, should carefully follow up the entire methods which are adopted for the handling of all the patient's bedding, utensils and discharges to determine where it is possible for flies to become infected in each individual instance. Active supervision and particular care should be constantly maintained to prevent fly infection. The patient's room should

be screened, the door kept closed and the room dark. Sufficient fresh fly-paper should be kept where it will catch all flies. All dejecta should be immediately sterilized and so handled and disposed of that it is impossible for flies to have access to them.

The prevention of flies having access to human dejecta is the principal method of checking fly transmission of typhoid fever. Where earth closets or yard privies are used, whether in the country or in towns, they should be made fly-proof by being built tight and screened. By the effective operation of a sanitary privy law, Dr. C. E. Terry in Jacksonville reduced the number of typhoid cases occurring in the non-sewered district of that city from 197 cases in 1910 to 65 in 1911. Ashville decreased her typhoid cases from 128 in 1910 to 69 in 1911 by the same method.

Placards should be posted conspicuously on houses in which are typhoid fever cases. The public has a right to know where these cases are located. The placards also serve to maintain quiet for the patient. Milk placards should also be posted to prevent the milkman leaving bottles of milk at the house. Householders should be required to receive their milk only in jars or pitchers which will not be taken from the house.

Immunization. — Anti-typhoid vaccination is the great preventive of typhoid fever. Its absolute dependence has been proved and its advisability amply demonstrated.[1] A comparison of the amount of typhoid fever in the United States Army before and since the adoption of the vaccination attests the value of its universal application to all bodies of troops and communities which are subjected to typhoid infection.

The one case in the Texas mobilization camp was of a man who refused vaccination. In the 1913 series one case

[1] L. I. Harris: "Typhoid Immunization," *Jour. Amer. Med. Assn.*, Jan. 2, 1915.

of typhoid fever developed in a man not vaccinated and two cases in recruits before their vaccination had been completed.

RESULTS OF ANTI-TYPHOID VACCINATION

	Men.	Cases of typhoid.	Deaths.
Without vaccination in Spanish War, 1898	107,973	20,738	1,580
With vaccination, Texas encampment, 1911	12,801	1	0
U. S. Army, 1913	90,000	3	0

In giving the immunization, three injections are given at intervals of seven or ten days. The injections are best given at about four o'clock in the afternoon, being made subcutaneously. The first dose given is usually of 500,000,000 dead typhoid bacilli and the second and third doses each 1,000,000,000 dead bacilli. The army vaccine is made to contain one billion bacilli in one cubic centimeter of solution. Maj. F. F. Russell, United States Army, recommended[1] that children be given doses in proportion of the ratio of their weight to that of the normal 150-pound adult. A child weighing seventy-five pounds, without regard to age, would receive half the adult dose. Paul used full adult doses with small children, reporting that they have less reaction than adults and that the full doses are well borne. Local reaction following injection is fairly constant, but varies in degree, being greatest after the first injection and varies with people. It begins to appear in four to six hours, reaches its full development in twelve, largely subsides within twenty-four and disappears in forty-eight to seventy-two hours. To avoid severe reactions[2] the vaccine should be administered only to the

[1] Maj. F. F. Russell, M. D.: *N. Y. State Journal of Medicine*, July, 1914.

[2] Drs. L. I. Harris and M. L. Ogan: *Jour. Am. Med. Assn.*, Jan. 5, 1915.

healthy; it should be given to permit slow absorption, avoiding puncturing blood vessels; the syringe should be sterile, and the skin sterilized by painting with tincture of iodine; children should avoid exposure to the sun, following treatment; do not administer during menstruation or pregnancy; allow no hard work or indulgence in alcohol after injection; and avoid reinjection in indurated areas. Anti-typhoid vaccination should be given before a person receives infection from a typhoid case, not after. The treatment is prophylactic, not curative.

The duration of immunity following anti-typhoid vaccination may last for some years or in some cases may be permanent. The immunity is perhaps not as absolute as that granted by an attack of the disease.

Anti-typhoid vaccination is hereby urged for all physicians, nurses, hospital attendants, laboratory workers and public health employees; hydraulic engineers, attendants of water purification and sewage treatment plants; plumbers, laborers and others connected with work upon house drainage and sewerage; for those nursing or living with typhoid patients or carriers; for traveling salesmen and others who travel considerably; for those living in railroad or other labor camps; for surveyors; for military and naval men; for all boatmen and seamen, especially those traveling on the inland waterways, lakes and rivers; for campers, vacationists, rivermen, lumbermen, dairymen, laundresses who handle soiled clothing, hotel cooks and waiters. In the presence of an outbreak of typhoid fever more or less wholesale immunization is recommended. Universal vaccination is recommended that typhoid may be banished from the earth.

To Disinfect Typhoid Discharges. — The urine and stools of every typhoid patient should be sterilized immediately after being voided. This should be done at the bedside if possible. After receiving the disinfecting solution the pan or other container should be covered and within five

minutes the contents be emptied into the sewer or buried. If the house be connected with a municipal sewerage system or have its own cesspool or subsurface drainage system the sterilized body discharges should be emptied into the sewer. If, however, the house is supplied with only a surface privy, of any pattern, or if its drainage discharges into a garden or stream, the disinfected typhoid wastes should not be emptied into the general house drain or privy, but must be buried. When buried they should be placed at least six inches below the surface of the ground, and immediately be covered with earth.

Boiling water is an effective disinfectant for typhoid discharges. When used, at least three times as much boiling water as the volume of the dejecta must be used; it must be added immediately to the discharges before they have time to cool; and it must actually be boiling when used.

Chloride of lime is a most efficient disinfectant. It must be used when dissolved. One tablespoonful of fresh chloride of lime is moistened into a paste with the same quantity of water. This is then added to one quart of water and kept in a covered preserve jar or stoppered bottle. Add a teaspoonful of blueing to color, as a warning signal. Of this chloride of lime solution one tablespoonful is added to each bowel or kidney discharge. The sterilization takes place almost immediately, except with solid masses. A warning should be given not to use valuable spoons or metal ware in handling the chlorinated lime.

Lime disinfection, according to the Prausnitz method,[1] may be accomplished by adding to the typhoid stool one cupful of ordinary fresh unslaked lime in small lumps, followed by one cup of hot water. The slaking of the lime will generate sufficient heat to kill the typhoid bacilli. The small pieces of dry lime should be distributed over the stool.

[1] Reported at Fifteenth International Congress on Hygiene, Washington, D. C., 1912.

Carbolic acid when used as a disinfectant should be employed in a strength of not less than one per cent of the volume of stool.

Corrosive sublimate is ineffective, unreliable and should not be employed in attempting to sterilize body discharges, owing to the insoluble inert albuminate of mercury which forms.

CHAPTER IV

CHILD WELFARE

The object of child-welfare work is the saving of babies' lives and the making of more healthy, more vigorous and more useful children and future citizens. It is the first step in the conservation of the human race and in the upbuilding of a nation. As with any other successful endeavor it should be continuous in activity, permanent in form, scientific, practical and efficient. It should begin before birth and should not cease. Child-welfare work covers four periods into which a child's life is divided: the prenatal period, infancy, pre-school age and the school period. The work in each quarter is carried along those lines which yield the best results and is extended through those agencies which are factors influencing the child's life. The basic principles of child welfare lie in education — education of the parents who are and of the parents who are to be. Parental realization and community cooperation are necessary for success. Thus will the children be saved, and the saved ones be made better and healthier children and adults. Educational and other public health activities are extended to the human family for the purpose of yielding more normal and efficient manhood and womanhood, that they in their turn may share in the production of another generation of better children. The continuous cycle of activities toward individual and race betterment will result in the realization of the hope of eugenics.

PRENATAL WORK

Prenatal work is special instruction and attention given to the expectant mother to conserve her strength for the

coming ordeal, to teach her how to care for her infant and to save child life. Prenatal work conserves the health and strength of the prospective mother; it decreases eclampsia, toxemia, nephritis and other causes of maternal fatalities. Its chief effect is baby saving, by decreasing still-births and infant deaths; it decreases ophthalmia neonatorum; it increases maternal nursing and improves birth registration. It decreases criminal abortion and the frequent deaths of women therefrom.

The expectant mother should be discovered early. Cases to receive prenatal care are secured by extensive publicity showing the good to be gained. The addresses of prospective mothers are obtained from interested friends, from church workers, from charitable organizations, from dispensaries and field nurses. In St. Helens, England, pregnancy is made a notifiable condition to be reported by midwives. This commendable legal requirement needs wider adoption as a help to the expectant mothers. Physicians generally should be requested to report cases of pregnancy, giving the date of the expectancy, and indicating if they wish or advise special literature or visiting nurses to be sent to the homes. The reports would also serve as checks upon birth records. When a prospective case is reported a nurse should visit the woman in her home and inquire about the contemplated obstetrical attention. If the case is judged to be one of the class to receive the prenatal instruction the nurse urges the woman to be registered early at a dispensary or with a physician. The nurse makes a social survey of the home and gives the needed instruction in regard to diet, clothing, fresh air, bathing, body hygiene, the care of the breasts and the avoidance of alcohol and heavy work. A printed circular of information is left. The woman is urged to visit the dispensary for a complete examination, including Wassermann tests when deemed necessary. The need of frequent urinalyses is explained. The nurse's visits are

repeated at ten-day intervals, she giving needed directions on the care of the baby.

The employment of pregnant women in factories is a cause of infant mortality and one underlying cause of underdevelopment or malformation of babies, and of neglect and disease in children. Certain foreign countries forbid the employment of pregnant women in factories. It is as damaging to force such women to do heavy labor and as wrong to give them the opportunity, as it is to employ young children in the mills. Pregnancy should constitute a legal cause for excluding women from factories, mills and schools. Women in such condition should be kept out of industrial establishments except perhaps those holding purely clerical or sales positions in certain offices. The period of exclusion should begin with the beginning of the pregnancy to yield the greatest comfort and benefit to the woman. The earlier the rest period begins the better, but no woman should be allowed to do any work in any store, factory, office, mill, school or other establishment later than one month previous to the expected delivery, and should be excluded without deduction in wages. The usual time of excluding women from work begins two weeks before labor and extends until four weeks after labor. No woman should be allowed to teach school after the sixth month of pregnancy.

The offering of bounties for babies assumes that all infants are equal or that superior parents will be influenced as much as will the inferior, these two assumptions being egregiously false. The bounties would induce children only in the inferior families. It is clear that any bounties should be upon greatly sliding scales, if adopted at all, and so graded that for certain families there should be a penalizing. The offering of cash prizes for child-birth produces undesirable results, since, if it increases the birth rate at all, the response will come from those families least able to care for their children, from those least willing to rear or to

protect their offspring. These are the undesirable parents and their children form a large proportion of the underdeveloped or degenerate children. The offering of the free services of a visiting nurse for the destitute has a different result. The indigent women should be notified, by notices displayed in dispensaries or by other ways, that they can obtain a nurse provided they make application early. The nurse, even by a single visit, can give much instruction to the mother and apply needed attention to the newborn.

Infants born into subnormal families fortunately suffer a great handicap in their struggle to survive infanthood, else the more fecund subnormal class would soon outnumber the high normal citizenry and the population would become one of mental degenerates. The work of overcoming infant mortality is not to accept all classes as they are born, but to develop through eugenics a better class of individuals. The alcoholic, epileptic or feeble-minded child is not to be saved as such, but his parents are to be investigated, examined and corrected. If their coming children cannot be made normal, these children should not be conceived. Effective means should be taken to prevent reproduction of undesirables. Where infant mortality is apt to result from some preventable disease in the parents, the special disease needs overcoming that the child may develop a physical vigor and ability to withstand the stress of infanthood. Mothers with tuberculosis deserve and should receive the appropriate treatment which will prevent their offspring showing evidence of the disease. The child of parents with venereal disease should be accorded the protection of prenatal or preconception treatment. This presupposes the necessity of the complete recording of cases of venereal disease, the value and need of health certification before marriage and more extended and complete work on the part of the family physician.

PREVENTION OF BLINDNESS

Ophthalmia neonatorum is a child-welfare problem and its prevention a duty of public health officials. Its prevention is easy and cheap, but its eradication is a subject more for the education of physicians and midwives rather than of the general public. Little can be gained in attempting to get parents to demand that their obstetricians apply the Credé silver nitrate prophylaxis. Parents will not acknowledge the danger of infection of the babies' eyes and do not realize that colon bacilli or streptococci can and do cause ophthalmia. The efforts to prevent the blindness of babies must therefore be directed toward the doctors, midwives and nurses. The registration of all people practicing midwifery and nursing should be complete. Professional midwives should be licensed under examination. Printed circulars of information and appeals should be sent to all acting midwives, doctors and nurses.

The legal early registration of cases of ophthalmia neonatorum should be enforced. For the prevention of the blindness of infants it is of the utmost importance that births be reported within forty-eight hours. Upon each birth certificate there should be included the question, "What measures have been taken to prevent ophthalmia neonatorum?", as is done in Minnesota. This legal provision reminds the obstetrician of his duty toward the child, it gives to the health officer information of how careful and attentive the doctors are, and in case ophthalmia develops it safeguards the careful obstetricians and partially indicates the careless. This requirement upon the birth certificate is the cheapest and one of the most effective means of getting the obstetricians to adopt the Credé prophylaxis. To have this question added to the birth certificate may require legal enactment. It should be printed upon the certificate in red ink. A certificate should be deemed not complete without the correct information. The report of a case of the disease indicates a need for checking up on the

birth certificates. A department of health can supply the physicians and midwives with the prophylactic dose of silver nitrate at a cost of less than five cents per baby, but these tubes if sent after the birth certificate has been received usually arrive too late to be of service. They may, however, be used in the next case. When supplied, these prophylactic doses should be made up in sealed glass tubes, and not in paraffin, rubber or other porous containers. Dr. Gardner T. Swarts has shown that there is a gradual increasing concentration of the silver nitrate solution in the wax tubes.

REDUCTION OF INFANT MORTALITY

The enormous death rate among infants is the greatest continual economic loss sustained by any nation. The reduction of infant mortality is a problem of the first magnitude. The problem is largely a local one, each community or municipality needing local surveys to determine the infantile mortality rates in the various sections, and to determine the operating factors and how they may be met.

The causes of infant mortality as recorded upon the death certificates are chiefly prematurity, congenital defects, digestive disorders, violence and infectious diseases. The practical causes of these conditions can probably be regarded as, respectively, industrial conditions of work, syphilis or obscure maternal injuries, maternal ignorance, carelessness or murder, and lax health administration. To these causes is added incompetent obstetrical service. Other postnatal causes which affect the infant mortality and which need local investigation include economic and environmental conditions under which the families work and live, the artificial methods of feeding practised, ignorance of the several members of the family, the practice of using children as caretakers for babies, and the presence of tuberculosis or other diseases in the family. A study of the local or individual occurrence of these various causes

of infant mortality will indicate along what lines activity should be exerted to prevent unnecessary deaths.

Midwives. — Midwives who are ignorant and careless become a direct cause of unnecessary deaths or injuries to infants and their mothers. Midwives cannot be suppressed until some provision has been made to care for the women who patronize them. Poor people are not able to pay the prices which well-trained physicians must charge, therefore they must seek the services of ignorant midwives. The sudden elimination of midwives is not a practical solution for most communities. The midwives should be registered, educated and licensed. Their elimination can follow the institution of trained nurses sent out from hospitals, or the other alternative is the admission to lying-in hospitals of all women who are known to be unable to pay a private doctor. Nurses, especially trained in obstetrical practice, boarded in and salaried by a hospital or other municipal or county institution, could be sent to attend the obstetrical cases in their homes, charging the ordinary midwife fee, which goes to the hospital. The proper publicity of such a system would acquaint the general public with its inauguration, and early registration at the hospital would be accomplished. This would offer the opportunity for effective prenatal work. After a reasonable amount of time had elapsed after starting the system, a heavy penalty should be exacted of all unlicensed medical graduates or others practising midwifery. Where such a system cannot be instituted the midwives should receive free instruction from a doctor who is competent to teach. The midwives should then, after a practical examination, be licensed.

Factors in Infant Mortality. — Summer deaths of infants are far more numerous than those occurring in other seasons, and may equal or outnumber the total deaths occurring during the other nine months. The causes of this excessive mortality during summer constitutes an important problem

to be solved for each community, that practical means may be taken to check the drain upon the human population. The causes of infant mortality in one city may be quite different from those operating elsewhere. Although the actual causes are quite similar, being due to improper food or clothing, diseases and maternal ignorance, the underlying influences which permit these operating factors vary considerably and need investigation. These contributing causes are local in their kind and are discovered by statistical comparisons and community surveys.

Excessive summer heat has been shown [1] to be one of the outstanding causes of infant mortality. Since the outdoor temperatures cannot be altered the infants should be kept at minimum indoor summer temperatures. Infants should not be kept in rooms in which the indoor temperature exceeds the outdoor hot summer temperature. Numerous observers have noted indoor temperatures in excess, and with fatal results for the babies. These high temperatures to which infants must be exposed should not be enhanced by excessive clothing or rubber diapers. The babies should be kept out of the kitchen in the summer time. To ameliorate the dangers from the excessive summer heat parents should be instructed to dress their children lightly and to keep them in rooms having a maximum of ventilation and air currents. The infants should receive the greatest available supply of fresh, pure air, and sick infants should be removed from shut-in houses or courts to localities where they may receive good air in large supply. Since the hottest part of a building is on the ground floor on a level with the street the babies in the crowded sections of the cities are benefited by being kept in cool but perfectly dry and well-ventilated basements, or by being kept in the upper floors of the houses. Liefmann and Lindemann found that the mortality of breast-fed babies increases

[1] Dr. J. W. Schereschewsky: *Public Health Reports*, Dec. 5, 1913, p. 2595.

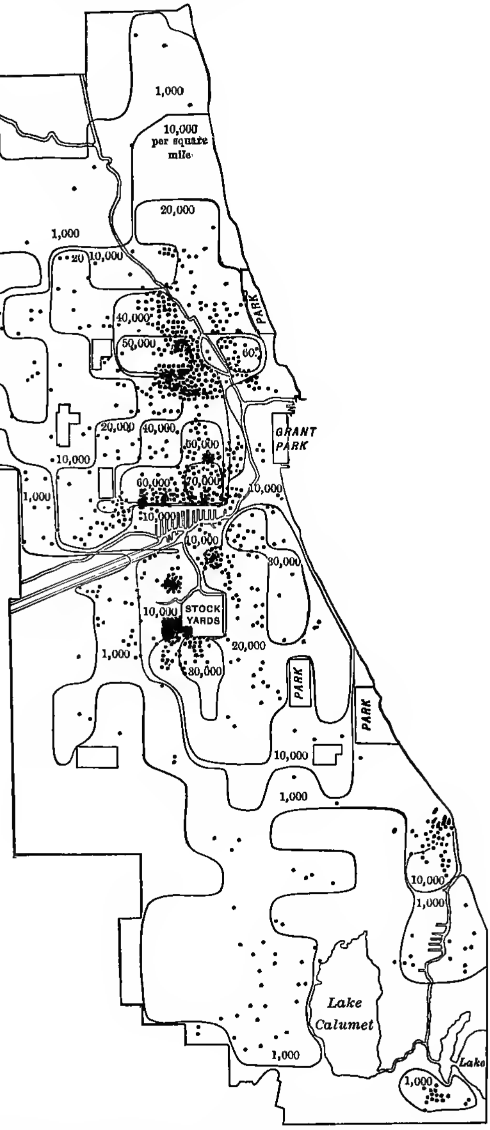
during the summer more than that of the basement children. Cellars which are not perfectly dry and well ventilated should not, however, be used as living quarters. Parents should be shown what measures to take to counteract as much as possible the effects of summer heat and be made to realize that cleanliness in the home is an important controllable factor which favors low baby death rates. Poor housing conditions can be partially neutralized by the proper care of infants.

Density of population within cities has long been regarded as a predisposing cause of infant mortality. It is probably only a secondary contributing factor, except that the opportunity for a dense population is the tall apartment building with small rooms, giving little ventilation, little sunshine, little play space and insufficient normal conveniences of life. The chief causes of high death rates occurring in such tenement neighborhoods really have less to do with the buildings than with the class of people living within them. Proper building construction should be provided but far more important is it necessary that these peoples be shown proper ways of living.

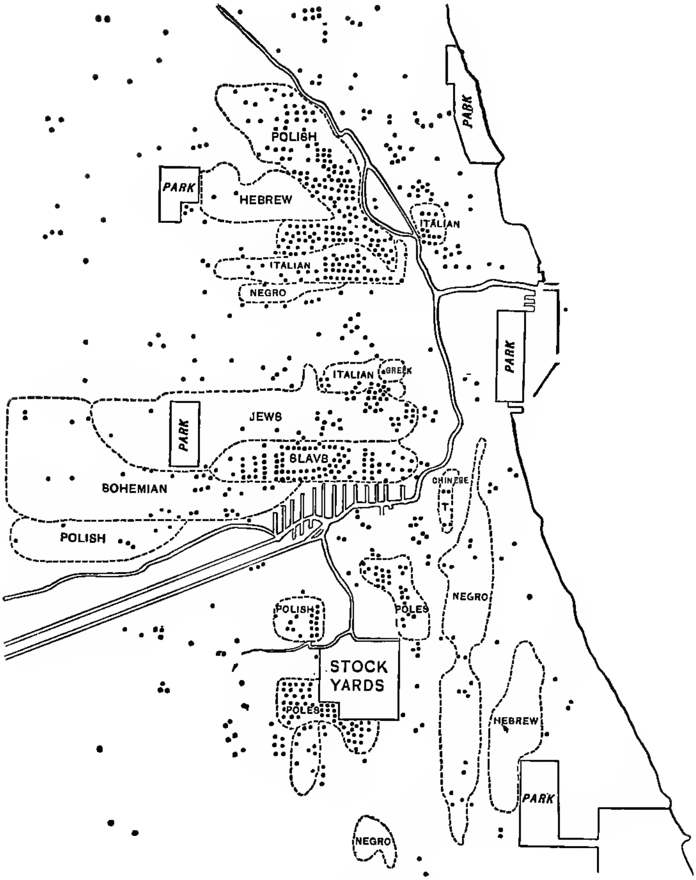
Race characteristics rather than density of population, and individual care of the babies rather than overcrowding in the homes are responsible for high infant mortality. These factors with the specific degrees of effectiveness should be studied locally to devise means for saving the babies. When the various factors producing a high death rate are learned, ways for their amelioration may be determined.

The comparative effects of race and overcrowding may be studied according to the writer's scheme as applied to Chicago in the accompanying maps.[1] During the summer months, July, August and September, 1914, there occurred 937 deaths from diarrheal diseases in infants under one

[1] Map-spotting of deaths by Dr. H. G. Ohls, Chicago Department of Health.



RELATION OF INFANT DEATHS TO DENSITY OF POPULATION



INFLUENCE OF RACE UPON INFANT DEATHS IN CHICAGO

Each dot locates an infant death. Racial characteristics rather than density of population account for high infant mortality.

year of age, which are herewith mapped. The proportional distribution of these deaths in the various districts corresponds very closely with that of the two previous years. The peoples of the various nationalities outlined live quite closely confined within these approximate boundary lines, as I determined and outlined. The solid serpentine isodemic lines on the other map include areas of one square mile, each having a total population (1910 Census) inclusive and in excess of the whole numbers represented. The maps show that the area of greatest density of population was among the Jews, living in excess of 70,000 per square mile. The areas showing a population in excess of 60,000 were populated by the Italians, and by Jews and Slavic races. The 50,000 population areas inclosed Jews and Italians principally. The greatest infant mortality occurred where the population varied between 30,000 and 40,000. These are the sections in which the Polish live. The Italians live in closer quarters than the Poles, but their infant mortality rate is much less than the Polish in Chicago. This is also true of the Jews. The Poles and other Slavic races are responsible for the high infantile death rate in Chicago. This is so marked that I predicted a certain district to be populated by Polish even when I was authoritatively informed that the people of that section were all Germans and negroes. A personal inspection confirmed my suspicions, which had been founded upon a study of this map. The area in question is shown by the group of deaths in the southeast corner of the map of the entire city having a population of 10,000. The nationality proved to be entirely Polish.

The unnamed residential sections are populated largely by Scandinavians and Germans in the northern area and by Americans, Germans and Irish in the other parts.

Mapping the individual deaths, the populations and the nativities, and constructed isogramic lines clearly define where further research work is needed, where field work

should be done by visiting nurses and where infant-welfare stations may be located. The map is but the beginning in the survey to be made. This is followed by a classification of the causes of death as shown on the death certificates. With this information compiled the investigator visits the houses in which the deaths occurred and makes a sanitary survey, getting complete data of the food and care given the babies. Knowing the habits of the mothers of the different nationalities the nurses can carry on their work efficiently and leave printed literature upon needed information.

The proper care of the soiled diapers of infants is an important item, especially in the southern states where the infant diarrheas are probably principally infectious. Levy obtained [1] a marked reduction in the death rate of infants in Richmond by the simple expedient of having visiting nurses instruct the mothers to care for the diapers by promptly emptying the dejecta into the sewers and thoroughly washing the diapers. This practical work reduced the death rate of infants under two years of age from a previous five-year average of 134.7 to 85.4, the average infantile death rate for the three years after the nurses began their special instruction in 1912.

Breast feeding must still be regarded as probably the most important preventive measure against infant mortality. Breast feeding should be attempted, encouraged and sustained through the hot summer months. This work for increasing maternal nursing can be carried on by appealing to physicians, by visiting nurses and by public education.

The improper feeding is the greatest cause of the enormous summer infant mortality. The solution is to help the mothers to nurse their babies. The mothers must be taught the advantages of maternal nursing. They should realize that four babies which are not getting their mother's

[1] Dr. E. C. Levy: *Rep. Health Dept.*, Richmond, Va., 1914.

milk die to every baby which is nursed by its mother. They should realize that natural processes are always superior to artificial and the ability to nurse her young is a woman's natural prerogative. With proper care and willingness every woman can nurse her child for awhile, until it obtains a solid foothold upon life; and through a persistency and earnest desire most women can continue the nursing a few months if not throughout the year. Indeed, Schwartz found that of 1500 mothers in New York 88 per cent were capable of nursing their babies 3 months, and 77 per cent maintained their function 6 months.

Milk Stations. — The advantage and necessity of maintaining supplies of clean, pure milk as a factor in preventing unnecessary sickness and death among artificially-fed babies and older children is discussed in the chapter on milk, together with the influences which keep milk clean and how they may be safeguarded. In large cities where the milk supplies are not pasteurized and the farms or systems are too widely separated or are too diversified to be completely controlled, the adoption of so-called stations will aid greatly in saving infant lives. An example is the excellent work accomplished by the Straus milk depots in New York City. These milk stations can be conducted as a private philanthropy, as begun in New York City, or as municipal depots, as in Rochester, N. Y. In such depots the milk is pasteurized (unless the dairy farms are well controlled); it is partially modified and sold at a minimum figure to the poor.

The proper care of milk in the house needs more intensive publicity by health officers. Fronzak's plan to paste educational slips on the bottle is excellent. These may be gummed labels or printed tags, and should state briefly how to care for the milk and how to feed the baby. On the reverse may be the dairyman's advertisement, provided it is truthful. The cardboard caps used in the top of milk

bottles should be printed, "Keep on ice," rather than the misleading and usually untruthful term, "Pure Milk." Milk bottles should have lettered upon their side, "Keep milk on ice. Scald empty bottle."

Infant-Welfare Stations. — Depots or dispensaries for the free treatment of the sick and under-nourished babies and to serve as day preventoria become one of the great agencies for saving baby lives. The stations are located centrally in the district where they are needed. A well-qualified physician and at least one nurse and one attendant are in charge. As each baby is brought to the station it is undressed, weighed and examined. Complete records of all babies are preserved, giving the name, age, sex and address of the child; the parents' names, nativity and occupation, the number of children and ages, with the number dead and the causes; and complete data on the care of the present baby and its progress, including the character of its food, times of feeding, care of milk in the home, general care in bathing, sleeping and airing, and clinical data. The nurse visits the sick babies in the homes to see if the doctor's orders are being followed and to give needed attention and advice. Bottled milk, modified to suit the baby's requirements, is given away or sold according to the financial ability of the station and of the families supplied. Free ice distribution is a philanthropy of great benefit, but an endeavor should be made to learn to what use the ice is put and what care is given the milk.

Necessary instructions are given the mothers at the welfare stations and in their homes. They are given leaflets on the care of babies, printed in their native tongue. Besides the verbal instruction and the printed leaflets given the mothers, they should be given the opportunity to learn from illustrated posters displayed on the walls of the welfare station. These educational posters should be simple, direct, impressive and be printed in the language the women can read. They should be illustrated when possible.

They may treat of such subjects as the care of milk, the dangers from flies, the value of early vaccination, the damages caused by comforters or pacifiers, the proper clothing to use, the damage from infected eyes, the proper food for babies and for small children, and other subjects locally applicable.

The visiting nurse, obtaining from these women reports of other babies, searches for the new patients. The mothers and children discharged from lying-in hospitals are followed up by these same visiting dispensary nurses or by other nurses belonging to the social service bureau of the hospitals.

Baby farms and infant boarding houses may have a considerable effect in increasing or in decreasing infant mortality. When conducted by ignorant or malicious women the babies are in constant danger of losing their lives. When properly conducted under the close supervision of the local health officer both these institutions can be made comparatively safe asylums for babies. Neither is recommended, however, as a necessary or advisable institution. I am in favor of absolutely abolishing all private baby farms, these commercial retreats where young infants, chiefly illegitimate children, are disposed of for a price. Where these concepts of immorality cannot be legally required to be housed in their parent's homes the children should be placed in state or municipal public foundling asylums to be reared under the joint financial support of the parents.

Baby contests, conducted for exhibiting babies for prizes, can have little influence upon improving babyhood. Baby shows are to be deplored, as they tend to create jealousy, create objectionable pride in older children and entail unnecessary expense for the parents. The babies are also subjected to the danger of a possible disease carrier. The points by which the babies are usually judged in the award of prizes are beyond the control of the parents, except in

the influence of clothes. When baby contests are held the baby score card formulated by the American Medical Association is recommended.

SUPERVISING THE PRE-SCHOOL PERIOD

The pre-school period comprises the child's life between the second and the seventh years. This is the period of a child's life which has been almost entirely neglected in the child-welfare movement. It is a time when children are difficult to reach, as the parents thoughtlessly believe little attention is needed and that the children can partially be left to their own resources. This, however, is one of the most important periods of life — when the character first begins to be molded by parental example; when the teeth begin to develop and the bodily functions are established and need guarding to be kept normal; the time when diseases and disorders of childhood are rife. This is the time of all times when parents need educating. It is the time when the children cannot be appealed to nor taught by public authorities. The supervision of this period of the child's life depends, therefore, upon effectual instruction being given the parents and efficient control being exerted over those persons who are left in charge of other people's children.

Mothers' Meetings. — Mothers' meetings form one effective way to indirectly reach the children of the pre-school age. The young children beyond the baby conference age, between the ages of two and seven years, need intelligent mother care rather than repeated personal medical inspection. Aside from the general educational work which is carried along by various means, these small children may receive their attention by talks to their mothers. The mothers' meeting should be held at some convenient, accessible point, preferably in a schoolhouse. A nurse or a physician should attend to teach the mothers how to care for their children. Talks are given on proper feeding,

correct clothing, the transmission of contagion, means of prevention, need of cleanliness, methods of play and allied subjects. Except in special instances the mothers should leave their children at home and not take them to the conferences. In these public meetings the parents begin to realize that the greatest inheritance a baby may have is a mother who knows how to take care of her infant.

Little mothers' clubs may be developed among school children of the upper grades. Children twelve to fourteen years of age should not be expected to care for babies, but they do take care of them and will be entrusted with these little lives. If thoughtless parents take this risk the danger should be minimized by educating these children in the proper care of babies. The little mothers' clubs should meet weekly, as on Saturday morning, and get their instruction from a trained nurse. The little mothers are shown how to dress, wash, feed and care for babies and little children; how to make clothes; and, especially, what not to do — what not to give the baby and when not to disturb it.

Public health exhibits upon the care of babies should be held in schoolhouses or wherever they will collect a large attendance. When held in schoolhouses the older children are apt to learn the care of their younger brothers.

Day nurseries, where children are left while their mothers are at work, should be licensed and supervised by the local health authorities. Frequent inspection should be made to ascertain that the children are receiving the proper food and attention to keep them well and are shown sufficient medical attention when sick. Complete records should be kept of all these babies, the record cards showing the home addresses. When a contagious disease appears in the house of one of the children a notification sent to the day nursery will avert an outbreak among the children there.

THE POST-SCHOOL PERIOD

The school life of a child represents an important division of child-welfare work, the practical consideration of the medical needs of school children requiring a special chapter. When the child leaves school, however, he should not be cast adrift but be given further special study and attention during the post-school period.

Continuation Schools. — The institution of continuation schools, where girls and young women can receive free instruction in housewifery, in the care of children and related matters, would be of great benefit for these girls after they have left school and are approaching the time when such instruction is especially needed. The mortality records show that picked up knowledge of house making is destructive to life. The rearing of children is a scientific proposition to be correctly taught, if not in the grade or high schools, at least in the continuation schools, as suggested by Dr. Putnam.[1] It would be of great advantage if domestic science could be taught in all grade schools, since many girls never enter high school. These girls, not given the proper advantages, are the ones generally most in need of instruction in household arts. Some domestic science is taught in some schools, but this education should include, besides cooking and sewing, instruction in the care of the house, in the care of foods, and the care of babies and older children.

When children apply to the factory inspector or the school authorities for certificates entitling them to work they should be subjected to a medical examination, especially if under sixteen or seventeen years of age. The work certificate, if detailing what work the child may do, or what he is not physically able to do, would further safeguard his health. The certificate should be definite in its

[1] Dr. Helen C. Putnam: *Proc. Am. Assn. Study and Prev. of Inf. Mort.*, 1912.

permission granted. A child, although of the legal working age, should not be permitted to work at such occupation as will undermine his subnormal physique, nor should he be permitted to work where, because of some physical or mental defect, he may endanger the lives of others. The certificate should specify the presence of certain defects, as uncorrected defective vision, color blindness, epilepsy, chorea, tuberculosis or other defect which may constitute a distinct danger, that the employer may act accordingly.

CHAPTER V

SCHOOL HYGIENE

The adoption of the various phases of hygiene as applied to school systems does not entail upon communities added burdens but confers upon them practical methods of prevention of disease and offers them opportunities for increasing school efficiency, childhood comfort and school attendance. Each part of the school surroundings and educational atmosphere should be established along those recognized lines of hygiene which are known to be beneficial, practical and healthful. This implies an attainment toward perfection in the sanitation, in the arrangement of rooms and classes, and in the physical condition of each scholar and each teacher.

Plans of proposed new school buildings, both rural and city, should be submitted to the state or city health departments for approval. This should be a legal provision. It is more convenient to criticise plans than to condemn a building, and obviously easier to alter the plans. Architectural plans should be designed according to the principle of hygiene rather than for artistic or economic conditions, but artistic effects should always be included when compatible with hygiene. The sites selected for schools should be central to the district served, but be distant from railroads and factories and not located upon street car lines or main automobile thoroughfares.

School grounds should be provided and equipped for scholars, provisions being made for those proper influences over the health, physical and moral training and recreation of the children which the yards can effect. The grounds should be open at all times, not enclosed by locked gates,

to be used as playgrounds. Where space permits, school gardens, planted and cultivated by the scholars, should be instituted in cities.

Safe water supplies and sanitary toilet facilities should be provided, their location and construction being in accordance with the practical suggestions as given in their respective chapters.

Since school houses belong to the communities the public should be permitted to use them for public lectures, public exhibits, voting places and similar community needs.

Recess periods should be provided. Five minute periods devoted to exercise within the class room are better than no time for relaxation, but are poor substitutes for the same time spent outdoors. If the exercise periods are taken for stimulation alone the ventilation of the room is faulty. Periods are needed for mental rest and body relaxation, not for stimulation, since the air supply should always be sufficient and proper to prevent mental apathy and somnolence. In the winter the children, in nearly every clime, should be sent outdoors for one or two minutes without wraps, accompanied by the teacher who recalls them before their bodies become chilled. Some attempt towards teaching graded and special exercises, including deep breathing, is essential for the classroom relaxation periods.

Hygiene should be included in the curriculum. Children should be taught how diseases are spread and how they may be avoided rather than being taught physiology or anatomy. Sufficient biology, anatomy and sex hygiene should be taught to induce the children to adopt habits of personal protection, body defense, cleanliness and health. The health educational movement as applied in schools will be considered in the chapter upon public education.

Washing facilities should be provided at all schools, and the scholars be encouraged, instructed or compelled to frequently avail themselves of the opportunities. Public roller towels, outlawed in some states, are a danger and

should not be tolerated. If the school is unable to provide paper towels or other individual towels which can be used but once, no towels whatever should be supplied. The scholars should be advised to bring their own towels, being drilled in the necessity of individual use and the dangers of the transmission of disease. In some localities the installation of bathing facilities for children would be advisable. These may be shower baths or bathing pools, as I

SCHOOL PLAYGROUND EQUIPMENT IN CHICAGO

have seen provided in some city schools and in Mexico. Community cleanliness would be greater and public health be upon a higher level if public bath houses, with their accompanying playgrounds, were located next to and as a part of school grounds, rather than at distant points. The system of playgrounds, outdoor gymnasia and bath houses should be located as an adjunct to the school. In the former the children should especially be taught obedience, attention, restraint and mutual help; while in the school they are taught healthfulness, cleanliness and body care.

Bubbling fountains or individual drinking cups should be provided the scholars. Common drinking cups, universally recognized as dangerous spreaders of disease, should be prohibited in every school. Where inexpensive bubblers cannot be installed, as in small city or rural schools, the scholars should be required to bring their own cups. The individual cups should be marked with the child's name, by painting or by a tag, to be kept in some definite place. The lending of cups should be made a punishable offense.

Cleanliness in the schoolroom is a provision the enforcement of which becomes a duty of the school physician. Upon each visit the medical inspector should note, also, the degree and need of ventilation. The desks should be wiped off each morning before use, by the janitor or by an appointed scholar. For this cloths impregnated with oily substances for retaining the dust particles are best. The use of feather dusters should be prohibited, as should vigorous sweeping with a dry broom. No carpets or rugs should be used in any schoolroom. Adequate and tight scrap-baskets and iron refuse cans should be provided where needed.

The cleaning of school houses should be done according to schedule, definite times for window washing being observed, as well as for the washing of school floors. Kimball reported that 44 of 528 schools admitted that the floors were never washed and 5 of 426 schools never washed the windows.

Lighting. — The proper lighting facilities within a school room will have a marked influence upon the comfort and efficiency of the scholars, and especially upon their eyesight. Bilateral lighting is best, admitting the light from large windows on the left and to the rear of the scholars. Left unilateral lighting should be adopted where the bilateral cannot be had. No other direction for admitting light to the children's desks is ever necessary nor should it

be tolerated. If a schoolroom is found admitting the light from in front or from only the right side, the room should be immediately condemned and closed until the desks are rearranged. Where light is admitted from three sides, including the front, the front windows should be closed by shades unless the front forms the long side of a rectangle. In such instance the desks should be rearranged to receive the maximum light from the left side. If light is admitted equally from both the left and right sides no rearrangement is necessary, but if there is an unequal lighting in the double set of lateral windows, that side admitting the most light should be on the left side of the scholars. Desks should not be arranged to suit the convenience of the scholars entering the room, or to be symmetrical with other classrooms or to keep the blackboards in front of the desks. Left side lighting and preserved eyesight are the sole considerations in arranging school desks. It is much better for scholars to turn around in their seats to see the blackboard, even to sit sidewise to see the board in the rear of the room than to write in the darkness of the shadow of their hands or to sit for hours facing the light.

The teacher's eyes and comfort deserve consideration when placing her desk or rostrum in a schoolroom. The teacher should not be expected to sit facing a long wall of bright glaring windows. If the windows to the rear of the children are along the long side of a rectangular room and are especially bright and glaring, the teacher's desk should be placed at the end of the room, even though the scholars' desks do not face the teacher. Before the desks are permanently fastened in place all these points of proper lighting and of proper place for ensemble should be provided.

Ensembled classes should be collected where the lighting facilities are the best. If they cannot be collected in a row of chairs or in a standing line where they will not be

facing windows but will have the light come from the rear, all reciting should be done from the desks. No class should be permitted to stand or sit, as an ensembled class, where the lighting facilities are inferior to those afforded the scholars standing at their desks. A class standing for reading should have the light coming from over their shoulders only, and ample room space before the windows should be provided. Standing a class facing the light impairs the eyesight, teaches carelessness by setting a bad example in hygiene, and always shows to visitors that the teacher is careless, thoughtless and inefficient in those points in class health and class efficiency in which she should excel.

Eyestrain is caused much more by poor lighting, glossy paper and reflecting blackboards, hard crayon and lack of proper instruction in the care of the eyes in home and school study, than by faulty or lounging positions at the desks. Good light is a prerequisite for good eyes — good light at the blackboard, at the desk, when in the standing class and when studying at home. The care of the eyes is the one fundamental fact to be ever remembered by the school teacher, to be provided for by the school board, and to be drilled into the school children. The objectionable faulty positions assumed at the desk are those in which the eyes are brought too close to the work. There is little evidence to prove that desk positions have more than a very minor influence in producing spinal curvature. Soapstone crayon, especially on wooden blackboards, makes only marks which are hard to see and which strain the eyes. Although chalk is much more dusty than soapstone crayon, it does not strain the eyes, and is to be preferred. The use of fine pointed pens for the young children beginning penmanship permits of small writing, leading toward eyestrain. I would suggest that only stub pens be supplied the earlier classes. Copy books as usually supplied the smaller children are too large, and the engraved lettering much

too fine,[1] eyestrain resulting. Cream colored writing paper is preferable to white.

Slate is best for blackboards. When it is not obtainable, wooden boards will suffice if properly finished. The finished coat should be black or very dark green, even in tone and with a perfectly dead finish, without the least indication of gloss or reflection. A board which reflects the light should be finely sandpapered or refinished. The best boards are of white pine or other soft wood, without grain or knots; they should be roughly sandpapered and then densely coated with dead black stain. A fine quality canvas may be used as a wall writing surface if stretched without furrows and painted the proper light or dark color, without leaving a reflecting surface. Chalk, not soapstone crayon, should be used. The use of light boards, painted a light olive or brownish or greenish yellow, to be written upon by charcoal or black chalk is suggested as a substitute for blackboards. Black chalk or artist's crayon used upon tinted boards would not give the trouble from reflected light, and the writing upon dark days or in poorly lighted rooms would be more legible. Owing to irradiation black writing upon a white background is not so distinct or legible as when upon a cream or tinted base. Walls covered with light boards will produce a lighter room than those covered with black boards, since the latter decrease the lighting of the room 15 to 18 per cent (Gstettner), and increase the necessity for artificial illumination.

Desk tops should not be glossy, but after varnishing should be rubbed down to a dead surface. Good window shades should be provided to prevent sunlight shining upon the desks or into the children's eyes, the inspector insisting upon their use. The desirability of exposure for classrooms is in the following order: easterly, southerly, then westerly. Larger windows are needed in our schools.

[1] Otto Grenness: *Trans. Fourth International Congress School Hygiene*, Vol. V, 1913.

Schoolbooks influence the eyesight. School boards should be required to submit, to the state department of health for approval, samples of schoolbooks which they are contemplating adopting. The books should be required to conform to the following recommendations, as suggested[1] by a committee of the British Association for the Advancement of Science:

Schoolbooks should be printed on paper which is neither glossy nor soft, nor so thin that the print or impression on one side will show upon the opposite side. The books should be so stitched and bound that they will lay open perfectly flat. (The children should be shown how to open a new book, by standing it upon the back, opening from each end, a few pages at a time and pressing them down.) The ink should be black and evenly distributed. The use of colored inks for reading matter is strongly deprecated. For young children line drawn illustrations are preferable to halftones, but simplicity in the former and distinctness in the latter are desirable. The lettering of cuts and diagrams should be large. For children under seven years the use of books should be postponed, and oral instruction, wall charts, blackboards and large pictures substituted. The type used in printing should be large, the letters not being distorted from ordinary type. For children of seven years the committee recommended as the minimum height of face for the short letters 3.5 mm. (a little over $\frac{1}{8}$ inch) or 18-point type. A length of printed line of 4 inches for the largest type, and of $3\frac{2}{3}$ inch for the other sizes was recommended. Wide margins are desirable. It is better to multiply maps than to put too much detail into one.

While reading, children should be taught to hold the book at the level of the lower end of the breast-bone, tilted to an angle of about twenty degrees.

The hygienic capacity of a schoolroom, or the minimum

[1] *Proceedings of the British Association for the Advancement of Science*, 1914, p. 268.

area per child, would depend upon many factors, including the average age of the class, the lighting opportunities, the ventilating facilities, the continuance of study hours and the desire of the teacher to give momentary periods for relaxation, exercise and stimulation by raising the windows to admit fresh, invigorating air. Overcrowding is a relative term and refers more to educational convenience and efficiency than to health conditions, since frequent medical inspection, proper ventilation and personal and room cleanliness will overcome the health disadvantages arising from overcrowding.

Open-air Schools. — As a reaction resulting from the overheated, poorly ventilated schoolroom, which has been too often forced upon the little children, a system known as the open-air school has been recently developed. It implies and includes much more than open windows and fresh air. Besides living in the open air the children are supplied special meals of nourishing food, graded exercises and enforced rest periods, special warm clothing and medical attention. They receive individual teaching in small classes. Obviously other causes besides fresh air contribute to the health benefits derived. The system is desirable but too expensive for extensive adoption. Modifications of the system may be used to advantage, the resulting benefits being in proportion to the degree of system adopted, each depending upon the available funds. Open-air schools are especially useful for tuberculous children. For regular classes maximum schoolroom ventilation and school lunches are of great benefit. Open-window classrooms have proved a measure of great value. The children are dressed warmly and all windows kept wide open. Muslin screens before the windows shield the children from the strong drafts.

Outdoor classes are an improvement over open-window classrooms and are recommended for adoption for anemic or tuberculous children.

The child of the rural school deserves as much attention as the city scholar; the proportion of his defects are about on the same ratio as in urban school life, but it is much more difficult for him to obtain the needed medical attention. The influences which produce eyestrain, bad teeth and various diseases and conditions are quite different in the country from those operating in the city life; but the defects of body, health and constitution are just as numerous and need just as much consideration.

The school junior health officer is considered in the chapter on public health education.

PHYSICAL DEFECTS OF SCHOOL CHILDREN

Certain well-known physical defects which may be found to involve a large proportion of the children of every school deserve the greatest consideration by health and school authorities, that they may be discovered and the children relieved of their infirmities which are so distressing, damaging and expensive. Correctable physical defects cause faulty development and susceptibility to contagion and are very largely responsible for truancy, repetitions in school work, delays of classes, inattention and inability to perceive. They result in waste of public funds, hence their correction is a public necessity, a public duty and a public economy. It is cheaper for a board of education to supply eyeglasses than to give extra instruction and added years of repeated school work. The majority of repeaters are unable to advance because of physical defects. Probably three-fourths of these repeaters will regain their class if the defects are corrected. Unrelieved of their infirmities these children will finally leave school and be unable to secure paying positions or work having advancement.

Scholastic fitness includes health as much as brains, and physical as well as mental development. The modern school is a physical strain as much as a mental strain, and before children are admitted to a certain class it is impor-

tant to know if their health as well as their intelligence is equal to the emergency. While his studies progress the child should receive repeated physical examinations to determine if the work is undermining his health, and if his bodily development as well as his mental development is keeping pace with the classes. Special classes are provided for mental defectives, and special consideration and training should be given those children who are physically deficient. Classes and children should fit each other; the minority members, whether they be below or above the general class, should be removed to receive special training or to be included in a class of their own caliber. This refers both to physical and intellectual conditions. Where deficiencies in these conditions can be remedied within the class the work should be done. Where irremediable the children should be removed from the class. Systematic examinations for defects should be made annually, especially for visual and dental defects. More frequent class examinations are unnecessary except in special cases. Where the teacher detects some special deficiency immediate examination should be made of the child and not be delayed until the time arrives for examining the class as a whole. The teacher is given a list of names of children and the defects found, with the recommendations offered. By weekly questionings she is able to learn from the scholars if the needed treatment has been received. If the child's condition has been neglected the teacher sends, with the monthly school report, a printed or written notice to the parents calling attention to the physical needs of the child and the effect of existing physical defects upon the school record.

Teachers should be included in those required to undergo the physical examination, partly as an example but principally to determine fitness and the presence of impairment. No person with tuberculosis or any other communicable disease should be permitted to teach. No person with

myopia over 6 D. should be granted a certificate to teach as she cannot properly teach the class nor appreciate normal vision or habits. All requirements of physical examination which are applied to scholars should be extended to include their teachers, but the teachers may be given the right to select their medical examiner.

School examinations are made to discover correctable physical defects, whereas school medical inspections are for detecting communicable diseases.

A standardization of the methods for making and recording physical defects is needed that the school conditions of one city may be made comparable with those of another, or that the children of one nationality or one class may be compared with another. The published records reveal such great variation in the percentages of physical defects that the need of standardization and of definitions is apparent. Without defining what is considered defective vision, there was reported in Lowell 10 per cent and Los Angeles 43 per cent of defective sight among the school children. Deafness was reported as involving 1.4 per cent of the Newark children and 15 per cent of those in the schools in Manchester, N. H. Four per cent of the Newark children and 36 per cent of those in the Harrisburg schools were considered as afflicted with enlarged tonsils. Other conditions show similar variations, which are due more to methods of recording than to variations in the actual conditions of the school children. The average conditions of collected cities cannot be accepted as a standard basis of comparison for other cities. Van Derslice in reporting the collected statistics of 153,503 children in 904 schools in 26 cities records[1] that 29.7 per cent showed defective vision, 2.1 per cent defective hearing, 35.8 per cent defective teeth, 24.2 per cent enlarged glands, 20.6 per cent enlarged tonsils and 6.5 per cent had adenoids. But even these figures cannot be used by any school to determine if the conditions in

[1] James W. Van Derslice: "Pediatrics," Dec. 1909.

that school are especially bad or especially good. Each city and each school needs to determine the amount of physical deficiency in the school children and to make every possible effort to eradicate those conditions.

Annual municipal reports should not only show the amount of physical defect found by standard methods of examination but should give the percentage of the different defects treated, the percentage of increase in health of the school children, and the variations in class average caused by the defects and their treatment, including the number of cases of communicable diseases found in the schools. These tables should be continued every year that the reader may note the benefits derived from school examinations.

Physical records of school children should be kept in the principal's office to show the needs of each child and to give the date upon which these needs received their attention. Individual record cards for filing alphabetically under each class are advisable. They may be attached to the scholastic record card or printed on the reverse side. Upon them are noted the presence of such physical defects as impair school work and health, and include the dates of beginning and ending of absence from school because of contagious disease. A data card may be devised for one year's records, or to include the whole number of years of school attendance. Upon the records should be given the height and weight of the child at stated intervals. Upon a comparison of the individual's height and weight with that of the class average are determined the points of faulty or insufficient nutrition. The need of school lunches and of variations in the ratio of work to play may be learned by a study of class averages. The use of anthropometric measurements to determine the ages and variations in growth and development is of recognized value that work may be undertaken to build up better manhood and womanhood.

Physical Examinations. — Physical examinations are most satisfactorily made in the office of the school physician

where the patient, accompanied by the parent, can receive in an hour's time quite a thorough examination. For these prolonged examinations the parents should be required to pay a special fee, as of one dollar, as was done in New York state. In office or schoolroom examinations the school physician does not prescribe, but merely diagnoses, prognosticates and advises, permitting parents full liberty of accepting advice and selecting their doctor for treatment.

Examinations in the school may be conducted with much satisfaction, the success depending upon the time allotted. The examinations are best made in some special and quiet room, two children being removed from the class, one to come and wait while the other child is being tested. A school nurse should be in attendance if possible; a teacher may be assigned to assist the physician, or a responsible girl from the higher class may assist when girls are being examined. If the arrangements can be made, the parents should be present. Some examinations of scholars may be made in the schoolrooms, but it is less distracting if the children are examined alone. Inspections to detect contagious diseases may be made in the schoolroom, standing at the desks if the lighting be sufficient, or made by a window. No child should have any exposures of the body or any unbuttoning of clothing done in the presence of other children, nor should any examinations be made for head parasites or other offensive conditions in any method by which the class may know upon whom suspicion or conviction falls. Since examinations are made not only to detect but to correct defects the work should be thorough, practical and systematic. Much can be learned by watching the children at work in the class, particularly in regard to visual defects and physical deformities.

Examinations are conducted to discover any defects of vision, hearing and mentality; any communicable disease; any heart, lung, eye, ear or skin disease; any physical deformity, orthopedic abnormality or nervous disease;

abnormal dental condition or defective teeth, enlarged tonsils and cervical glands; adenoids or other respiratory obstruction; any acute fever or illness or any other evidence of impairment of health.

Vision. — Tests of eyesight are made to determine the probable need of attention, and not to determine definitely the kind and degree of refractive error. Ophthalmoscopy and refraction are unnecessary except where some special research is being done. For the purpose of advising a child to consult an eye specialist the Snellen test is sufficient. The child is directed to read from a Snellen test card hung with the center at a level with the child's eyes at a measured distance of 20 or 30 feet; where possible, 30-foot distances should be used. Examinations will be misleading unless the test card is brightly illuminated. The eyes are tested separately, the one not used being shielded by a card. The child reads from the largest letters downward, and the vision is recorded as fractional numbers: $\frac{20}{30}$ signifying that at a distance of 30 feet the child was not able to read correctly below the line marked 20 (the line which should have been read by the normal eye at a 20-foot distance). The missing of two letters is counted as an incorrect reading of the line. Astigmatism in the child is detected by a running or unequal blurring of the letters, by the child rubbing the eyes or tilting the head. Since a child even with a considerable degree of myopia, by forced or unconscious accommodation, may read the normal visual lines, the child must be questioned regarding symptoms of eyestrain. By using only the Snellen card a number of defective eyes may pass undetected. Dust or inflammation in the eye also annuls the usefulness of the Snellen test card. The use of the Snellen card alone will detect most of the myopes having an astigmatism over one diopter, but by asking for symptoms the examiner will find nearly all the others with myopia. The Snellen test letters should be of correct size, the interspaces and parts being of

equal width and each one-fifth the height of the letter, and made to subtend at the desired distances twice the tangent of an angle of one-half a minute (2 tang. 0.5′).[1] A letter meant to be read at 100 feet should be $2\frac{3}{16}$ inches in height, those for other distances in corresponding proportions, letters to be normally read at 20 feet being $\frac{7}{16}$ inches in height, at 40 feet, $\frac{14}{16}$ inches.

Hearing. — Tests for hearing should be conducted in the quietest room attainable. The examiner should standardize the room by testing himself to determine the greatest distance he can hear the test apparatus, watch or tuning fork, comparing this distance with the maximum measured distance through which the same test noise is audible in a perfectly quiet room. By this standardization and correction of records of the classes, he is able to make one class comparable with another.

The testing apparatus used should be a tuning fork, or the examiner's watch will suffice. The tuning fork most adapted for the work is the 514 C. Watches are excellent for testing the hearing but they vary greatly in the intensity of the tick. If the watch is used it should be previously standardized by being tested upon a number of young adults believed or known to have normal hearing. This testing is done in a perfectly quiet room, and the average maximum distance it is audible is taken as the standard distance of that watch for normal hearing. The examiner then tests himself within the same room. The ratio of his maximum distance to the average normal is taken for determining the amount of noise present in the school examining room; as an example, if the average normal was six feet and the examiner heard at the same distance, he has normal hearing. Upon retesting himself within the schoolroom if he can hear the watch but four feet, owing to the continual rumbling noise of school buildings or street

[1] Dr. B. A. Randall: "Trans. International Congress on School Hygiene," Vol. V, 1913.

traffic, the results of the school tests will represent hearing distances which are recorded as $\frac{4}{6}$ of the normal. If the doctor in this schoolroom hears the watch 4 feet and a certain pupil hears it but 3 feet that pupil's hearing is recorded as $\frac{3}{4}$, but the pupil's distance will be 3 feet increased by $\frac{2}{6}$ or equal to 4 feet. The fraction $\frac{3}{4}$ does not represent the child's acuity of hearing, since the intensity of sound varies inversely with the square of the distance. For purposes of comparison with other children or with later tests of the same child the child's hearing may be recorded as $\frac{4}{6}$.

In testing the hearing the tuning fork or watch is brought from a great distance slowly toward the child, who is prevented from seeing it. Upon repeating the trials the maximum distance at which the watch or fork is audible is noted, testing the ears separately. It is frequently necessary to hide the watch in the pocket to prevent deception. No clock should be permitted to tick in the same room, interfering with the test.

The whispered voice should not be used for testing hearing owing to the great unintentional variations in it made by the speaker. Under some confusion or noise the speaker would whisper louder or stronger, and the whisper cannot be standardized. Since a speaker does not hear himself as others hear him he is unable to appreciate or know the amount of noise he makes in whispering.

Records of deafness in a school should not state that a certain number showed deafness but should state the number having $\frac{1}{2}$, $\frac{2}{3}$ or $\frac{3}{4}$ normal hearing. Deafness is a meaningless term unless specifically defined, and school records stating "5 per cent showed deafness" are valueless. The found causes of actual deafness should be enumerated in reports. Before treatment is recommended the probable cause should be ascertained. Cases of temporary impaired hearing from colds or impacted cerumen should not necessarily be advised to seek medical treatment.

Enlarged Tonsils. — In making throat examinations in a school no tongue depressors should be used if they can be avoided. If absolutely necessary to use a tongue depressor only wooden spatulas should be used, and after each is used upon one child it is discarded and burned. Abnormally enlarged tonsils should be classed as those hypertrophied or as those diseased. Hypertrophied tonsils are those of large, globular, smooth, and hard contour, and are disadvantageous chiefly by causing obstruction. Diseased tonsils include those of moderately large size, soft, inflamed and having an uneven surface of deep crypts. These, rather than the globular hypertrophied tonsils, demand attention. They are considered responsible for many systemic infections, since they offer special inducement for pathogenic bacteria to enter. Cases of tonsillitis are not included in the class of diseased removable tonsils. Removal of hypertrophied tonsils need not be recommended unless there are evident signs of obstruction or unless the occlusion has decreased the size of the faucial passage to an accepted degree — to one-third the width, being hereby suggested. The so-classed diseased tonsils are probably always a menace, and if large and troublesome their early removal is recommended.

Adenoids. — Mouth breathing, chronically discharging nose, muscular depression of nasal alæ, inattention, stuffy speech, "song" pronounced as "sogg," a narrow upper jaw and high arched palate and deafness, are the indices of adenoids. A definite diagnosis of adenoids cannot be made without a rhinoscopic examination. No health officer is justified in inserting a finger into the pharynx to examine for adenoids. Mouth breathing does not always indicate adenoids; it may be caused by acute coryza or defects of the septum or palate. It does indicate needed attention.

Adenoids large enough to cause obstruction or mouth breathing require removal. Very small adenoid growths may disappear about puberty, but large ones may remain

permanently. Adenoids which cause occlusion may cause permanent deformity of the face, and by restricting breathing cause permanent deformity of the chest. Their early removal will result in better school work, more concentrated attention to calls and duties, better physical development and resistance to disease, less sickness and discomfort, and an improved appearance of the face.

Defective Teeth. — All children having defective teeth, of any degree of defect of any teeth, should be urged to consult competent dentists. In recording the results of the examination of a class more will be gained by reporting the proportion having perfect teeth and also those showing fillings or other evidence of dental attention than to report the percentage of defectives. Records should be kept of those children advised to seek a dentist, that repeated pleadings may be made to the parents when earlier reports are disregarded. The health officer, however, should warn the parents not to have the early teeth removed before the second eruption loosens them. The necessity of the filling of all small cavities should be impressed upon parents. The health officer is frequently asked what should be done regarding decayed teeth. There is not a unanimity of opinion regarding the disposal of primary teeth having large cavities but frequent and early attention should be urged. The writer is opposed to extracting any teeth which prolonged treatment will save. After the third year everybody should be examined semiannually for defects of the teeth.

Dental hygiene should be taught to the classes. It is very necessary for children and adults to understand the value of good teeth, the transmission of diseases from and to the mouth and the care of the teeth. Instruction should begin in the kindergarten and be carried to the senior class.

Dental clinics should be established in connection with schools to give needed treatment to those who would not or could not go to dentists or distant dispensaries. In small cities where dental clinics cannot be established the prac-

tising dentists may be willing to devote a few certain fixed hours to the treatment of the poor, the school physician directing the children to seek these services.

Faulty Posture. — The faulty positions assumed by scholars at their desks are chiefly objectionable in that they cause eyestrain by bringing the eyes too close to the work or at oblique angles. The writer cannot concur in the commonly expressed opinion that faulty posture in school causes spinal curvature. The irregular positions are not long maintained, especially the sideways sitting which is suspected of causing scoliosis. It is advisable, however, for the teacher to correct the children who lounge, since the correction teaches discipline and exercises certain body muscles. Frequently, faulty posture in sitting and in standing is the result of defective vision, insufficient nourishment and rest, and lack of home training, rather than the cause of physical defects. The teacher should supervise the children and prevent their working with the eyes closer than about nine inches from the work when reading or writing.

Examinations should be made for flat-foot, especially with the younger children, for with them the condition may be amenable to the treatment of proper exercises and inplates.

Weak ankles and carriage in girls deserve special attention in school, the girls being taught the correct standing posture. The girls should be taught hygienic dressing, and urged to avoid the styles or habits of dress which are harmful to their well-being.

Mental Deficiency. — Cases of defective mentality may be detected by a close scrutiny of a class or upon an examination given those children reported as backward or showing signs of subnormal mentality or moral perversion. Defective children having physical defects of vision, hearing or breathing may show mental inaptitude, inattention, inability or more marked evidence of lack of mental de-

velopment. Upon correction of these defects many of the children will become sufficiently normal to assume an advanced position in class work. Some apparent cases of mental deficiency are cured upon the correction of physical defects. When the physical condition of the defective is as nearly normal as possible, the children should be subjected to a careful Binet-Simon mentality test to determine their fitness for remaining in the class, or for selecting the needed class or needed attention. Noticeable cases of mental deficiency should not be included in any class of normal children, but should be taught alone. Separate schools and separate classes for the defective and backward should be provided.

INSPECTION FOR INFECTIOUS DISEASES

A medical inspection of all scholars will frequently reveal the presence of unknown cases of communicable disease, and the early elimination of these cases from a class will check the transmission to other classes. When a contagious disease exists in the neighborhood and the members of a class or school are apt to be exposed to it, daily examinations of all children should be instituted. Any child found having any of the early signs or symptoms of the disease should be excluded at once, even though his condition leads only to suspicion and not to definite diagnosis. The examiner must of necessity be well acquainted with all points of differentiation, and hence must have had a medical training. Typical cases of disease are the exception, rather than the rule, as found in school inspections; the decision for exclusion is frequently made upon the unexpected signs, as upon submaxillary soreness or swelling in mumps, nosebleed or a red patchy throat in measles, vesicles in the palate in varicella, minute vesicles in smallpox, and white palatal patches in scarlatina. These are all strongly diagnostic but might not be considered by a lay inspector. The diagnosis and control of contagious disease in school

by a nurse is but a half-way measure and may be illegal. It should be done by a physician.

Medical inspection within schools serves not only to check school outbreaks in their incipiency, but is a means to discover and control other cases of communicable disease which have not been reported. Children who are absent from school for causes unknown to the teacher may be visited by a physician or nurse and found to be ill with some contagious disease. Children who have been absent over three days should be isolated from their classmates upon their return and be examined by the school physician. Some of them will show symptoms of beginning infectious disease. When two or more cases of a disease are reported to the health officer as having attended the same school or the same class an immediate inspection of the class should be made, as a mild or unrecognized case may be found in attendance at school or some playmate who was the cause of the infection may be located. When a house inspection is made in search of a suspected case of communicable disease, if examination or entrance is refused, the children of the family should be found at school and examined, or all children from the household excluded from their schools.

School inspections should be done under the authority and control of the department of health rather than under the school board. School boards are competent to qualify and appoint medical inspectors, but the educational boards, not knowing of the presence of other cases of contagious disease in the community, are unable to determine the presence of any special menace which might arise. To have a child with a contagious disease under the control of different boards when within or without school, or to be excluded by one board and isolated by another, might lead to confusion. The rules of one board might declare a child a public menace or infectious, and yet the laws of the other may declare the child in safe condition to attend school. A child should not be debarred from day school by one board

and admitted to Sunday school by another equally authoritative body. Children with contagious diseases, from the beginning of their infection, are health and not educational problems, and, therefore, should be under the control of but one and the proper authority, whether they are found within school or elsewhere. It is true that the question of physical defects in school children is an educational rather than a public health problem, but for purposes of economy, simplicity of methods and the practical centralization of authority, to the school health doctor who inspects for disease should be entrusted the duty of discovering and eliminating correctable physical defects. Fundamentally there is little difference whether these examinations for physical defects are made by school or health authorities, provided the work is done scientifically, practically and effectively. Better consideration may be obtained in some instances when the school boards have full control, but they might then be done more according to convenience than necessity. The health authority should arrange the school work to give the minimum amount of confusion and delay to the school, but under no condition should school work be permitted to interfere with that more important work, the acquiring or maintaining of health for the school children.

The school nurse forms a valuable adjunct to the medical inspector. The purpose of the nurse is not to diagnose conditions but to aid the school physician in having proper treatment given where needed. School medical examinations for defects are of little benefit unless they accomplish the getting of a large proportion of the defects corrected. For this the nurse is needed, and with her much more can be accomplished than simply by relying upon written requests sent to the parents of the children. The nurse may assist the mothers of poor children in getting these scholars into health. She may help to stamp pediculosis or other parasites out of a household. She may apply surgical

dressings in the homes of the poor. Her other duties include the explanation of the necessity of correcting defects; she persuades parents to have the defective or diseased eyes or ears given their needed attention; she induces parents to have operations done upon adenoids or diseased tonsils, when necessary. The nurse selects and sends certain under-nourished children to charitable organizations to be sent to the country or seashore. One great duty is for the nurse to show, teach and explain cleanliness. The school nurse has proved her worth.[1]

Exclusion from school should be extended to school children, teachers, janitors and visitors having any one of the legally reportable diseases, except for conditions not infective or transmissible, and for certain other infections or infestations. Exclusion should persist until the person is well or cured, or is otherwise past the stage of infectivity. Excludable diseases and conditions should include smallpox, scarlatina, measles, chickenpox, active tuberculosis, diphtheria, influenza, tonsillitis, whooping cough, mumps, trachoma, acute conjunctivitis, acute colds, fevers of serious diseases and of unknown origin, syphilis, erysipelas, scabies, pediculosis including nits, ringworm, favus, impetigo contagiosa, and any especially unsightly or offensive condition. The time for exclusion of the contagious diseases may be considered according to the accompanying table. After a known exposure a child is permitted to attend school until near the end of the minimum period of incubation, and is then excluded until the average maximum incubation period has passed.

Exposed persons who have had a previous attack of a disease, or who have been artificially immunized, are regarded as immune to the disease. These children may attend school, except the children exposed to diphtheria or scarlet fever shall be required to remove to another resi-

[1] "Health and Medical Inspection of School Children," by Dr. Walter S. Cornell, 1912.

dence in order to attend school. Exposed persons who have not previously had the disease, or have not been artificially immunized by vaccination or injection with serum, are regarded as susceptible to the disease. When they begin to develop symptoms of the disease, they are classed as patients.

PERIODS FOR EXCLUSION FROM SCHOOL FOR DISEASE

Disease.	Patient	Susceptible and exposed persons	
	excluded until	following first exposure	excluded for
Chickenpox.....	All crusts drop off	10 days	7 days
Diphtheria.....	2 negative cultures obtained	Immediately	Until negative cultures, 7 days later
German measles	14 days	7 days	5 days
Measles.........	Disappearance of cough and discharges	7 days	10 days
Mumps.........	7 days after swelling goes down	10 days	10 days
Scarlet fever....	3 weeks or longer	Immediately	14 days
Smallpox.......	All crusts drop off	Vaccinate and exclude	14 days
Whooping cough	3 weeks or to end of whoop and paroxysms	7 days	14 days

Vaccination. — Vaccination should be legally required of every school child entering any public school or any parochial, private or boarding school or college. A successful vaccination should have been obtained once, and a repeated trial at vaccination attempted within ten years of the primary vaccination. Vaccination certificates which are signed within five days of the time the vaccination was done are useless and should not be accepted. The date of vaccination and the date of certification should be required

upon all vaccination certificates. Any child not showing a correct certificate or a good scar of a successful vaccination should not be admitted to any school.

The Disease Census. — The disease census is an exact enumeration of the scholars of each class with a list of the various communicable diseases each child has had. The disease census forms one of the most practical methods for determining how to control disease within a school and its compilation should be included in the duties of every school medical inspector, school nurse or teacher. The census is obtained by asking the individual scholars respecting the disease each has had. Their answers are usually reliable in the aggregate. For children of the first two grades printed cards sent to their mothers for information are preferable, since the small children have not all learned of their past sickness.

A SCHOOL DISEASE CENSUS SHOWING PER CENT AFFECTED

Disease.	June, 1912.	June, 1913.
Chickenpox	41	65
Diphtheria	5	4
Measles	71	79
Mumps	16	61
Rubella	22	....
Scarlet fever	24	29
Whooping cough	....	65

The value of a school disease census may be appreciated from an experience of the writer when health officer of Rochester, Minn. The figures given include the children from the first to the eighth grades, inclusive, being a compilation of the diseases of 769 scholars in five schools. The numbers shown are the collective percentages of those children who had had the individual diseases. The first census showed that the school children were especially susceptible to diphtheria and quite susceptible to chicken-

pox, mumps, rubella and scarlet fever, but not very susceptible to measles.

During the intervening school year outbreaks of chicken-pox, measles, mumps and German measles appeared, with the existence of some few cases of the other diseases.* The first census indicated that if diphtheria and scarlet fever appeared in the schools they could work havoc. It was also known that mumps would involve many children, and, if it were desired to prevent it, immediate closure of a whole school upon the appearance of the first case would be necessary. If measles should appear in the town the census showed that closure of the schools would avail little, as there were but one-fourth of the scholars susceptible. In the outbreaks which occurred the cases of mumps and measles were approximately equal in number, the second census showing that the mumps occurred chiefly among school children, but the measles attacked chiefly those below school age. Excepting later infections, three or four years in the future will see classes susceptible to mumps, but only slightly to measles.

When obtaining the disease census the health officer is enabled to obtain a list of the diseases which the children have had during the past year, and also the number of cases or names of those members of the scholars' families who also have had the diseases the previous year. These data will serve as a check upon the morbidity reports as obtained by the vital statistics bureau. The disease census of an individual school will also indicate what particular diseases are to be feared in each room. Measles is more to be feared in a room having many susceptible children than in one in which nearly all are immune. The properly informed medical inspector will know the conditions to expect and will be able to anticipate what closure of a school or of a class could accomplish for the specified disease, and will act accordingly. He will receive reports of such cases of disease as appear within the district supplying his school,

and will be able by a disease census to anticipate probable outbreaks of disease with their extent of involvement in the different classrooms.

Expectant school diseases are those diseases which may reasonably be expected to involve a large number of children of a given school. They include those diseases to which the greater number of scholars are susceptible, in the relative ratio of the percentages of susceptibility. These percentages are easily determined by the disease census. For the practical elimination and control of contagious diseases within schools a child who has had one attack of a contagious disease may be classed as being immune to that disease. Conversely, those children who have not had a certain disease should be considered susceptible to the disease, although not all children will contract the disease when exposed. Artificial immunization would remove a child from the class of susceptibles. The factor of disease incidence upon exposure would influence the susceptibility of a class, but should receive little weight in the control of disease within a school. Susceptible children when exposed are much more apt to contract measles than scarlet fever, or mumps than diphtheria, but even with the more serious diseases all children within a school should be considered to be susceptible to all these diseases unless they are known to have become immune by natural or artificial processes.

The closure of schools to avert an outbreak of a contagious disease deserves practical consideration. It may be of great advantage and necessary, or it may be useless and harmful, depending upon local conditions. The conditions include the opportunity for infection to be introduced and for the contagion to spread. The degree of opportunity is determined by consulting the city map upon which is spotted the location of cases of disease. Comparing this map with one showing the limits of the districts supplying each school some knowledge of the possible introduction of

infection may be learned. The opportunity for the spread within the school of any introduced infection is dependent entirely upon the ratio of susceptibilities, as determined by a disease census.

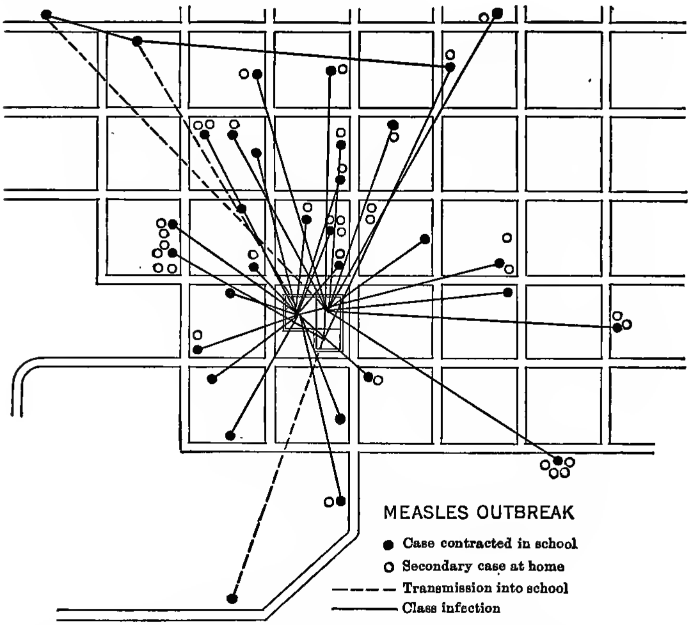
The factors which determine the advisability of closing a school for a contagious disease include the probability of extensive involvement and the practical control of the children. Extensive involvement in a school may be expected when the school disease census shows a high percentage of susceptible children. If a case of measles appears in a lower grade room having many susceptible children in a school building in which the other classes show few susceptibles, closure would avail little as one room is already exposed and later exposures of other rooms could do little damage. If the other rooms contain many susceptible children closure of the first room or of the entire school may be advisable. When a town has become saturated with a disease it may be necessary to close all schools and use other measures to prevent children communicating with one another. The closure of a single schoolroom to check the spread of infection within that room will be of little benefit, except to escape the influence of carrier cases. When a contagious case appears in a schoolroom practically every child who is going to be attacked will contract the disease from the first exposure, especially with the highly infective diseases, measles, whooping cough and rubella. There will be comparatively few secondary cases arising from those primarily infected by the first case. With these diseases closure of a room in an attempt to save it will give but little result. With the lesser infective diseases, scarlet fever, mumps and diphtheria, there will be a greater proportion of return cases; therefore closure of a single room for these diseases may prove of great value.

Carrier cases of disease within the schoolroom call for different methods of control. The organisms of carrier cases are probably of less virulence than those of cases of

disease having symptoms. The transmission from carriers does not occur with the same explosiveness as occurs when a case in the earlier and more infective stages of a contagious disease appears in the schoolroom. The occasional or continual appearance of new cases of a disease would throw suspicion towards the presence of a carrier. If the carrier cases can be discovered, as with diphtheria, and eliminated the procedure is indicated. If this is not possible or feasible, closure of the schoolroom is indicated.

Tracing Outbreaks. — When a case of disease appears in a schoolroom the exposed susceptible children should not only be excluded when the minimum period of incubation has passed, but the control should be extended to other school children and to other susceptibles within their families. The primary case infected by the original case within the school may develop the disease and produce secondary cases at home. These secondary cases may far outnumber the primary cases coming from school and may be far more dangerous as they are less apt to be reported and segregated. In a school outbreak of measles which I investigated, 67 primary cases developed the disease upon exposure to 5 original cases in 5 classes of 3 schools. These 67 school cases gave rise to just 100 secondary cases at home. One-fourth of the primary cases were seen and reported by physicians to the health officer, the writer; none of the secondary cases were reported. A secondary case developing within the household which has not been visited by a physician, being unreported and unrestricted, may carry the disease into another school or may infect another family which will introduce the disease into another school. The involvement of other classrooms of the same school building may occur through outside transmission by the home secondary cases, as is clearly shown in the accompanying diagram. Since physicians do not see all the cases of the contagious diseases which may involve a city or village, it becomes the duty of the health officer, the school physi-

cian and the visiting nurse to follow up the susceptible contacts and control the early cases. The advantages to be gained by this work are evident.



Disinfection. — Disinfecting a schoolroom can serve but a very limited purpose. If a teacher has been found to have active tuberculosis the room should be thoroughly scrubbed and cleaned after the teacher has been excluded. Formaldehyde disinfection, if sufficiently concentrated, will help and may be done, but it should be extended chiefly to the books and to the teacher's desk and papers. Upon discovering a tuberculous teacher all papers in her possession and belonging to the children should be destroyed. The disinfection of a classroom after any other disease is practically useless. Since diseases are spread by carriers and human transmitters, and not by dust, reliance should

be placed upon careful medical inspection and not upon disinfection. It is useless to disinfect after diphtheria unless every child in the class has had two cultures made from both the nose and throat, and all diphtheria carriers excluded. If scarlet fever outcrops in a school all susceptible children should be excluded until the maximum period of incubation, three weeks, has passed. Their removal and the exclusion of any child who has had a suggestive scarlatinal infection within three weeks will obviate the employment of any disinfection. Cleanliness of classrooms should always be maintained and disinfection abandoned.

CHAPTER VI

PURE FOODS

Purity in food products is largely but not wholly an economic problem. Impure milk is distinctly dangerous, diseased meats may be able to transmit some diseases, but most instances of impurity or adulteration are deceptions only. Full measure and full weight are but economic questions.

The misbranding of medicines is a far greater evil than the adulteration of drugs. It is as great a danger for some inert substances to be branded with miraculous but impossible powers as for standard pharmacopœial drugs to be weakened by dilution or long storage.

It is desirable that the federal Pure Food and Drugs Act be kept up to the standard of medical and chemical science, that deception, fraud and danger in foods and drugs be eliminated. State food and drugs laws should be as exacting as the federal act.

Food Values. — The nutrient values of foods have been standardized according to their caloric potential strength. The calorie, taken as the unit for comparison, is the amount of heat which will raise one liter of water one degree centigrade in temperature. One unit of dried food substance upon burning produces one calorie. In determining food values the heat units are termed small or large calories. The large calorie is equal to 1000 small calories; the small calorie is the heat produced which will raise the temperature of one gram of water one degree centigrade.

The food value in calories per pound is obtained by multiplying the sum of the percentages of carbohydrates and protein in the food by 18.6, and by adding to this

product the product of the percentage of fat multiplied by 42.2.

$(\%\text{ carbohydrates} + \%\text{ protein}) \times 18.6 + (42.2 \times \%\text{ fat}) = \text{food value in calories per pound.}$

The nutritive ratio of a food is estimated by Sherman's formula, the results being expressed in large calories per 100 grams. The percentage of fats contained in the food is multiplied by $2\frac{1}{4}$, then added to the percentage of carbohydrates and divided by the percentage of proteids:

$$\frac{\%\text{ carbohydrates} + 2\frac{1}{4}\ (\%\text{ fats})}{\%\text{ proteids}} = \text{nutritive ratio.}$$

Foods should not be accepted solely according to their caloric equivalent. Calories constitute the best present laboratory basis upon which to judge food values, but that food producing the greatest number of calories upon analysis is not necessarily the most desirable food. A balanced food, as milk, offers greater advantages than a high calorie food, as cornmeal or rice. The most desirable food is a mixed ration which yields sufficient nutrition, energy, stimulation and indigestible waste products. An unbalanced food is lacking in certain needed qualities. Such a food is dangerous, as it may produce digestive disturbance or disease. An example of such disease is beriberi, produced by a diet of polished rice, or pellagra, produced by a dietetic fault in some animal or vegetable food component.[1]

As a working basis, it is usually accepted that a man at hard work needs from 3500 to 5000 calories daily; under light muscular work, from 3000 to 3500 calories; and a man or woman of sedentary life is satisfied with 2500 to 3000 calories in food value. The requirements of the body are not so simple as the mere addition of the caloric equivalents of foods, but for determining the quantities of foods to supply, as in military rations, the calorie forms a provisional standard.

[1] Joseph Goldberger, C. H. Waring and D. G. Willets: Pellagra, *U. S. Public Health Reports*, Oct. 22 and Nov. 12, 1915.

It has been estimated that a man at hard work requires $3\frac{1}{3}$ ounces of protein, $3\frac{1}{3}$ ounces of fat and $17\frac{1}{3}$ ounces of carbohydrates to meet the demands of the system each day. This is approximately equal to $6\frac{1}{4}$ quarts of milk with $\frac{3}{4}$ pounds of sugar, or to 1 pound of beefsteak with $2\frac{1}{4}$ loaves of bread, or their equivalents in other articles of food. In actual practice, however, a more mixed diet is preferable to a meal of two components, although their caloric food values may be equal.

Food Preservatives. — It is not the purpose of this book to enter into the controversy on the supposed need or alleged dangers in the use of benzoate of soda. Suffice it to state that chemical preservatives are not necessary. If there is even a question that these preservatives may be harmful to the consumer they should be left out. It has been proved that benzoate of soda or any other chemical preservative is not necessary to use in the manufacture of catsup, salad dressing, pickles, condiments or canned goods. A proper proportioning of the ordinary food contents of good stock and sterilization by heat at the right temperature will impart lasting qualities to these foods. Decomposition of raw foods is a natural consequence following excessive dampness or drying, increased or decreased temperature and exposure. Decomposition in the spoiling of foods is thermal, meteorological, chemical or bacteriological. These effects can be retarded or prevented by artificial means.

Artificial Coloring of Fruit. — The term, artificial ripening, as applied to fruits, especially to oranges, grapefruit and lemons, is a misnomer, as it does not ripen the green fruit but simply changes its color. The sweating process to which these fruits are sometimes subjected after being picked green, is for the purpose of making them salable. It is an artificial color development, since it has little material effect upon the composition of the fruit substance. Certain fruits picked for long shipment are occasionally

gathered unripe. A method of converting this green fruit into the fully ripe state, having all the qualities of taste, composition, digestibility and food value of fruit ripened on the twig, is needed. The artificial sweating process is improper. It damages the fruit and deceives the customer. The determination of artificial coloring of citrus fruits is established upon the chemical evidence of immaturity. The Bureau of Chemistry considered[1] grapefruit to be immature if the juice does not contain soluble solids equal to, or in excess of, 7 parts to each part of acid in the juice, the acid calculated as citric acid without water of crystallization. With Florida oranges the ratio should be equal to or in excess of 8 parts of soluble salts to one part of acid, to indicate maturity. These proportions are subject to later revision.

Cold Storage. — The subjection of fresh foods to freezing or near-freezing temperatures permits the foods to be kept wholesome and palatable for many weeks, to be used at a time when they cannot ordinarily be produced or to be shipped to a region in which they cannot be grown. The system of cold storage has markedly increased the supply of green or unpreserved foods and decreased the consumption of canned goods. It has made possible the use of tropical fruits in colder climates, but these tropical fruits are picked green at a time when their flavor is inferior to that of the fruit ripened on the tree. Cold storage foods are inferior to fresh foods or to naturally ripened fruit, but where cold storage foods are sold the superior foods cannot be obtained at all or in quantities sufficient to meet the demand. Since cold storage foods when exposed to warm temperatures decompose more rapidly than foods which have not been subjected to extreme cold, these foods should be kept cold until cooked or eaten, and should not be exposed for long periods at warm temperatures. Eggs

[1] Dept. of Agriculture, Bureau of Chemistry: Service and Regulatory Announcements, No. 15, Nov. 4, 1915.

preserved in 5 per cent aqueous solution of water-glass (sodium silicate) are said to be superior to cold storage eggs.

In order to hold eggs successfully in cold storage for several months all leaking eggs, and the pasteboard fillers which are wet, must be removed. Leaking eggs cannot be marketed because of the condition of the shells. If these eggs are removed from the shell they should be handled in a place and manner to prevent any contamination of the liquid eggs. Precautions are needed to prevent unsound eggs being added to the liquid material. Egg-breaking establishments should be licensed, inspected and controlled.

Butter which has been kept in proper cold storage is better than fresh butter, since there will be less opportunity to contract infection from it. Fresh butter contains several million bacteria to the cubic centimeter. These rapidly die and may decrease from a few millions to 50,000 within a few days according to Conn. Rosenau has shown [1] that butter containing 4,110,000 bacteria per cubic centimeter showed a bacterial content of only 582,000 two weeks later, and in six weeks the bacteria were reduced 95.6 per cent.

Candling Eggs. — The freshness of eggs, their chief quality, is determined best by candling, an inspection of the eggs when viewed with the light shining through the shell. The egg is held against a bright light in a darkened space to overcome any glare or halation from side lights. It may be candled by holding at the end of a long tube of paper through which the inspector looks. An egg which has just been laid and is still warm entirely fills its shell. But as it cools to the temperature of the air it contracts, leaving a small empty space at the large end of the egg. As the egg ages this space increases in size from evaporation of moisture through the shell.[2] A large air space indicates

[1] Milton J. Rosenau: "Market Butter of Boston," *Jour. Med. Research*, Mar. 1914.

[2] "Effect of the Present Method of Handling Eggs," by M. E. Pennington and H. C. Pierce: Yearbook of Dept. of Agriculture, 1910, p. 461.

staleness and is seen by candling. A fresh egg, held before the candle, shows the yolk but faintly, as a reddish ball in the center of the shell. It moves if the egg is quickly rotated, but is disinclined to do so. As the egg ages the position and opacity of the yolk changes; it becomes freely movable, either rising or falling and becoming more distinct. The rotten egg is opaque or dark colored, and is due to a developing chick or to fungus. A "spot rot" is an egg in which the yolk has stuck to the shell or in which fungi have formed a visible growth, and is due to long holding.

Candling and grading form the basis for the correct purchasing of eggs. Eggs should be considered only according to these measures. The grading of eggs is done according to the freshness, the results of candling and the size. The coloration of eggs probably has nothing to do with their nutritive value. Since infertile eggs keep better than fertile ones farmers should be encouraged to dispose of their roosters as soon as eggs needed for hatching are obtained. The eggs should not be washed by farmers, but clean nests should be maintained. Eggs from stolen nests should not be marketed. Eggs should be kept in cool, dark places, and never be exposed to the sun. Any eggs exposed to hot sunshine for an hour will spoil. Eggs should be kept away from all odorous substances, as coal oil, fish and decaying vegetables.

The dating of eggs becomes a practical and useful method, when done under cooperative agreement. Such is the Danish plan of developing egg cooperative associations. The territory covered is divided into sections, the members of the several sections being known by numbers. The members agree to collect eggs twice a day, to date them and to store the supply in cool places. Each egg is stamped with a rubber stamp, giving the day of production, section of association and producer's number; thus, July 10 M 8. The eggs are shipped to market twice a

week. These eggs command a high premium. Bad eggs are eliminated from the market by this method. The origin of each egg is traceable. There is a penalty for incorrect dating.

Dating. — The dating of all packages of foodstuffs is advised, especially for cold storage foods. This would provide for placing the date of manufacture or preparation on all canned, bottled and boxed foodstuffs, including meat products, milk and its products, eggs, canned vegetables and fruits, condiments, pickles, canned soups, preserves and other such articles not sold in the raw state, and those which may deteriorate by long storage. Dating protects the producer and the consumer, and also the retail middleman. Foods placed in cold storage under a time limit, after the lapse of the time, are removed to another state and improperly sold or stored as though freshly prepared. The dating of foods would tend to prevent this sale of over-stored foods.

Licensing. — The licensing of people who handle foodstuffs should be put upon a medical basis. All people who handle for sale, or who sell foods of any kind should be licensed, and the final license for all agents be given in one office. These people who are subject to license before being permitted to engage in their food business should include grocers, bakers, soda water dispensers, hucksters, oyster openers, restauranteurs, fruit and candy sellers, push-cart food peddlers, dairymen and candy makers. All people engaging in any of these occupations should be examined and granted license only after they have been pronounced free from tuberculosis and typhoid infection. The examinations should be made by a physician of the health department, or written reports from private physicians may be accepted. In New York City tuberculous persons who do not show tubercle bacilli in the sputum may receive license to become push-cart peddlers. License should not be granted to milkmen or dairymen who may be

suspected of being typhoid carriers. It is usual for different classes of workmen in these occupations to receive from their different departments ordinary licenses to do business. The recommendations for license may safely be granted by different offices but the final health license for all classes should come from the same office, in the health department where a card catalogue of each business may be kept. When an applicant desires a license to sell food products of one class the card catalogue may be consulted to see if a license for some other food business had been rejected, and for what reason.

FOOD INSPECTION

An inspection of all places wherein food is prepared, handled, stored or sold is desirable, as a protection to the public. The inspection is made to determine if the food is fresh and clean, if it is protected from dust, flies and other animals, if it is kept under the proper conditions of temperature, light and moisture and if it is handled in a clean manner by healthy persons. Food stores are also inspected to determine if all weights and measures are correct and truthful, and if scales are working properly. Ready-packed foods are inspected to determine if they are sold under full weight or full measure. Foods are also inspected to detect any fraud or evasions of the law by being adulterated.

Tolerances. — Tolerances are allowances in short weight or short measure. I do not believe their existence is justified except as a leeway. It is regarded unjust to include them in the laws to be read by the public. A pound of butter should weigh a pound when the purchaser buys it as such. To permit a tolerance of two drams to the pound, stating legally that the producer may have his pounds weigh two drams less than a pound, gives the producer a chance for short weight and an opportunity to save two drams from each pound. In the course of a year

this gives a big retaining of butter for which the public has paid. In measures, a leeway should be permitted, to be exercised at the discretion of the food inspector. A pound is a pound, but in measuring a liquid quart the measurement depends upon the temperature and upon the height of the meniscus, a point not easy to determine in large measures. It is difficult to declare when a quart measure is exactly full. In using a dry measure much depends upon the amount of shaking down or compression which has been effected. The degree of compression is an effective item in measuring flour, sugar, rice, salt or other similar articles by bulk. In judging short measures discretion should be exercised by the inspector who should consider the apparent intent of the grocer. This practical point is also considered in measuring liquids whose bulk varies with temperature. Quart bottles filled with a hot fluid will not hold one quart of the same liquid when it has become cool.

Tolerances or shortages as allowed by the Pennsylvania law include 4 drams to one quart of milk; with butter $\frac{1}{6}$ ounce in a pound; coffee $\frac{1}{2}$ ounce in a pound; oils, flour and dried fruits a shortage of 1 ounce per pound, and with other foods in general an allowance of from $\frac{1}{4}$ to $\frac{1}{2}$ ounce per pound. The Rules Relating to the Food and Drug Law of Connecticut detail (1914) a long list of allowances.

Condemned Food Products. — Food products condemned because of various conditions usually become a total loss. In some special instances they may be used for other purposes. Condemned meat products from slaughter houses may be converted into fertilizer, but should not be fed to hogs. The grease may be extracted from this class of condemned goods. Condemned vegetables may be fed to hogs or chickens if not too decomposed, or moldy or sour. Condemned eggs are becoming, in some localities, totally waste products. Tanners, who formerly bought the rots and spots, have found a cheaper substance to re-

place the egg substance in the tanning. None of these condemned foods should be treated in any way to be used as foods for people. Condemned flour may be used for paste.

Waste Products. — In the preparation of foods certain portions of the natural food substances are discarded and become waste products. Many of these are valuable and become by-products to be converted into other foods or useful articles. This is legitimate if the so-called waste portions are of good quality. In large slaughtering establishments practically no part of the carcass becomes an absolute loss. In fowl dressing packing houses the only waste is the blood and feathers. The feathers are sold for use in pillows, toys, millinery goods, and the stiff " pointers " of turkey wings become feather-bone stays of woman's apparel. In canneries, jellies are made from the waste from the fruit, and tomato wastes are used in catsup. Catsup made from trimmings should be so labeled.

Canning Foods. — Canneries need public supervision. Canning establishments should have assured pure water supplies. Their products should be uniform in content, unadulterated, of good and selected fruits and vegetables, prepared to have lasting qualities and properly branded. The name of the packer should be upon every can and bottle. It is important to know where goods are canned, as the information gives further assurance of the quality of the product. Tomatoes and other vegetables and fruits should be properly sorted before being canned, and all unsound ones removed. The efficient washing of vegetables and fruits to be canned is important. The washing should be done by a continuous stream of fresh, pure water. Where vegetables are soiled by clay soils and a tank washer is used the water should probably be admitted at the bottom, to overflow at the top. An outlet at the bottom would also permit the occasional withdrawal of the heavier particles of soil.

Canning wastes should be handled in a way not to create a nuisance or not to contaminate or befoul water courses. The solids in the waste, as occurs with canning tomatoes, will damage fish life if discharged into streams. It is advisable to remove the solids by settling, skimming and sieving, or perhaps by filtration through a sand bed. For the liquids a system of broad irrigation may be tried.

The reprocessing of the contents of bulged cans or of spoiled canned or preserved goods should be prohibited, as the retreatment cannot overcome the chemical effects brought about by the decomposition.

Grocery Store Inspection. — In inspecting grocery stores more attention is given to the methods of handling foods than to the actual conditions of the supply in stock. There is little spoiled food now found in stores, not often can decomposed canned goods be found and vegetables are usually well picked over. Attention is given to the habits of cleanliness of the employees. No person who has tuberculosis or who recently has had typhoid should be employed in any grocery or other food supply store. Such habits as the licking of the fingers or the holding of meat knives in the mouth should be prevented. The licking of the fingers and the blowing into paper bags to open them should be prohibited. Dogs, cats, rats and mice should be excluded from food stores. Cellars and bins should be made rat-proof, and all food be stored so as not to be available to vermin. No live chickens should be kept within the store, but may be kept and displayed in the back yard.

The storing and keeping of food in a grocery store should be done with a view of preserving the foods and preventing their becoming contaminated, rather than for convenience or decorative effect. The counters and shelves are usually filled with canned goods. These spaces should be reserved for the foods which become damaged by floor dust if they are kept upon the floor. Foods not damaged by

the floor dust raised by the passing customers may be kept upon the floor if it is impossible to provide shelving, but in all progressive, advanced grocery stores no foods are stored or kept upon the floors. All foods which are eaten uncooked should be effectively shielded from flies, dust and public handling; foods which are damaged by drying should be kept under glass or in other tight containers; and foods which spoil or deteriorate by heat should be kept within a cold refrigerator.

CARE OF FOODS IN A STORE

May be kept on the floor.	Elevated 12 inches above floor.	Shielded from flies, dust and hands.	Kept closed under glass.	In the refrigerator.
canned goods	artichoke	berries	bread	butter
carrots	cabbages	celery	cakes	cottage cheese
cucumbers	cantaloupe	cherries	candy	dried currants
nuts (whole)	cauliflower	crackers	cheese	eggs
onions	cranberries	dates	opened fruits	fresh fish
peas	dried fruits	figs	pastry	fresh meats
potatoes	dried meats	grapes	pies	milk
pumpkins	grapefruit	lettuce	radishes	mincemeat
squash	lemons	peaches	shelled nuts	(fresh)
turnips	oranges	pears	watermelon	oysters
watermelons	plums	prunes	(cut)	raisins
	pickled food			
	spinach			

An inspection is made of the fresh vegetables and fruit in stock to remove all decomposed or defective products. Green corn, peas and string beans should not have a faded look. Cabbages should be crisp and bright, and not having either dried or soft rotting leaves. Beets, cucumbers, turnips and carrots should be firm to the touch. Head lettuce should show no trace of the rusty red look that announces long keeping. It will keep its freshness longer if the root is left on. Lettuce or celery should not be sprinkled except with water of known purity. Sprinkling should not be done by the hands but by a watering pot or

other sprayer. Oranges, grapefruit and lemons are inspected to determine if any artificial coloring has been done. Such fruit having a color of ripeness but a very hard consistency may be suspected of having been "sweated," especially if some specimens in the same box show dark green areas. Specimens are then removed for chemical analysis. Raisins, mincemeat and currants in packages are inspected for the presence of worms. Small, pin-point perforations of the paper wrappers or little accumulations of lemon-colored granular particles, like flour, but of the bulk of a pin head, indicate worm infestation and require condemnation.

Canned goods are inspected to detect the presence of old stock, leaking cans and of "swells" and "springers." Swells and springers are indicated by the bulging end of the cans and the crackling noise made upon pressing on the end. Swells are due to decomposition, defective preparation permitting the formation of gas. Springers are overloaded cans containing good stock. The two kinds of swollen cans cannot always be differentiated without opening. The swells show a content of gas formation, an excess of acidity, dissolved tin in solution and many molds or bacteria. For safety, both swells and springers should be condemned. A swelled can gives a splashing noise upon shaking, which is not heard with the springer.

Street Food Stands. — The storing of foods for display or sale outside of and on the pavement or street in front of food stores, and belonging to the stores, should be discouraged or prohibited. The use of street stands, wagons and push-carts by small food venders is a legitimate business, necessary for the existence of certain people. Where they may interrupt traffic a nuisance may be created. Where stands or wagons are permitted, the fruits or foods should be above the reach of dogs and be entirely covered or enclosed under glass. Food venders should be licensed, and be required to be free from infectious diseases. It is

unjust and impractical to have restrictions for the care and handling of foods by grocerymen in stores without making similar requirements to control the small food venders.

Meat Market Inspection. — Inspection of meat markets gives a valuable control of the methods of handling meats, but all inspection should be done to obtain practical results and not to be hypercritical of necessary untidiness. The use of sawdust upon floors is to be condemned as it tends to permit the accumulation of small pieces of decomposing meat. Floors should be kept as clean as convenient and possible, and not be kept as hiders of dirt. Meat chopping blocks, counters, knives, saws and refrigerators are inspected for their cleanliness, notation being made of any small pieces of meat which have remained and decomposed. The rear of the premises is inspected to note the presence and condition of killing or dressing rooms, the condition of choppers, sausage machines, trying-vats, quarters for live chickens, and for the location and appointments of toilets and washing facilities. The killing and dressing of animals, except chickens, in a meat market should be prohibited. Live chickens should not be kept in cellars but should be given suitable quarters, clean, airy and light. They should be separated by at least two doors from the stored or dressed meats. The methods of handling, storing and disposing of meat scraps and offal should be investigated and any nuisance be prevented.

The personal condition of the employees needs special emphasis. Butchers and their assistants should be licensed by the local health authority, the permit to carry on the business being granted after an examination by a physician satisfies the examiner there is no existing infectious disease. Any person with any infectious disease or who has recently recovered from one, or with any skin disease of the hands or arms, or with any infected wounds of the hands is not a proper person to butcher or handle meats.

The meats of the markets need inspection to determine

if they are stored at proper temperature, protected from dust, flies and other animals, to note the presence of a federal service inspection stamp and to observe the condition of the meat.

Spoiled beef is wet, flabby and pink or purple and with a distinct foul odor. The iridescent hues occasionally found upon beef do not indicate decomposition. Bad veal is soft, mushy, sticky and has a very red tinge; the fat is a grayish, lead color. Good pork has pure white fat. Pork that is soft and yellow should be discarded. Stale poultry is flabby, bluish green on the crop and the abdomen has a bad odor, the eyes are sunken and the skin is easily pulled apart. All shellfish should smell fresh and the shells should close when touched or put into water. Shellfish, lobsters and crabs should be alive when cooked. Fresh fish have red gills and moist bright scales and clear eyes. They are firm and rigid when handled.

Any meat products which are condemned should not be simply set aside and instructions given to the storekeeper to throw them out. Many salesmen would put these condemned goods back on the counters for sale. Condemned meats should be treated to prevent their future sale. This may be done by pouring coal oil over the meat or, with large cuts, injecting kerosene with a syringe into various places.

Inspection of Dressed Poultry. — Beginning decomposition in dressed poultry is shown by the appearance of a greenish hue of the skin at the side of the neck, first appearing below the ears. Undrawn poultry decomposes[1] more slowly than does poultry which has been wholly or partially eviscerated. Full drawn poultry, that which is completely eviscerated, with the heads and feet removed, decomposes the most rapidly. "Boston drawn" and "wire drawn" stand midway between the undrawn and full drawn in

[1] Dr. M. E. Pennington: U. S. Dept. of Agric., Bu. of Chemistry, Circ. No. 70, 1911.

speed of decomposition, the "wire drawn," which is the more like the undrawn, being the better. These comparisons relate to the poultry which is given prompt delivery and marketing.

In the full drawn poultry the body cavity is opened by a transverse cut across the abdomen. The vent is entirely excised and the head cut off. The heart, liver, cleaned gizzard and excess body fat is replaced in the cavity. The feet and shanks are removed. In "wire drawn" poultry a loop of intestines is pulled out by inserting a finger through the vent, the loop is cut and the intestines are pulled out, breaking at the gizzard. The vent remains *in situ*. In this form the abdomen collapses, this being the only sign of any dressing being done. "Boston drawn" is like "wire drawn" except that a circular incision is made around the vent and the entrails are pulled through until rupturing at the gizzard.

Restaurant Inspection. — Restaurants may be graded during the inspections, numerically scored by a detailed score card, or graded after a general examination of the cleanliness, absence of odors, personal hygiene of employees and equipment of the kitchen. In inspecting restaurants cognizance is taken of minor details, and where improvements are needed suggestions should be made. It should be insisted that spoons are kept bowl down in the spoonholders, that unused clean plates are not exposed to flies, that tumblers are stood upside down to escape dust and flies, that napkins do not long remain exposed to dust blowing in from the street, that pies and pastry are enclosed within glass cases and that tumblers are used but once. The employees should be watched as they work to note their individual points of carelessness. In the kitchen the items deserving especial observation include the presence of flies and of cats, the presence of accumulated filth and collected scraps, the condition of health of the employees and the condition of the refrigerator and its contents.

The temperature of the milk and the freshness of the meats are noted. The source of any objectionable odors is determined. Decomposed foods are discarded. Any condemned foods should not be set aside with the request that they be thrown out. The inspector does the throwing out, and, with condemned meats, should destroy them, as by pouring upon them some coal oil. Any vegetables found in opened cans in the refrigerator should be condemned, as a guard against ptomain poisoning.

Paper plates, paper tumblers, paper forks and spoons and a better grade of paper napkins are desirable for improving the hygiene of the restaurant and for lessening the expense of operating.

Ice Cream and Soda-Water Stands. — Soda-water counter inspection is done principally to learn of the care given the glasses and of the use of adulterated fruit flavors. Drug stores should be encouraged to adopt paper soda water drinking cups and to use a holder or method which will prevent public handling of straws or their contamination by flies. Wax paper ice cream containers and paper spoons are desirable.

Bakery Inspection. — The rooms used as bakeries should be light, well ventilated, kept clean and with impervious flooring. Some cellar bakeries may be sanitary, but such hygienic conditions in cellars are obtained with such difficulty that cellar bakeries should usually be eliminated. The placing of bread crates on the front street and the placing of bread upon the floor should be prohibited as dangerous. Toilets should be removed from baking rooms. The greatest danger, that arising from lack of personal cleanliness, cannot be removed by legal enactment. Flies and cats should be eliminated. Rats and mice should be fought by rat-proofing and starvation, not by cats or poison. An inspection should be made of the dough vats, bread mixers and machines to note the care with which they are kept clean. The wrapping of bread, cakes and buns and

the boxing of pies should be encouraged. No breadstuffs should be handled, sold or transported without being wrapped and protected from dust and dirty hands.

Meat Inspection. — The inspection of meat, next to milk inspecting, constitutes the most important watchfulness which is placed over foods. The records of the results obtained by the federal meat inspectors attest the necessity of extending the service and the work to include all meats slaughtered for sale. The animals slaughtered in the large packing houses are usually carefully selected, and will show a smaller proportion of diseased conditions than will the general run of animals as slaughtered in small towns or by individual butchers. The reinspection of government inspected meat is unnecessary and useless. Where this meat, imported from the large packing houses, is checked at the post of entry by a municipal revenue agent, as a means for collecting revenue or taxation, the term inspection should not be adopted.

A municipal abattoir is the solution for many of the difficulties and preplexities resulting from the small, unsanitary slaughter houses. The abattoir may be built by the city and all slaughtering required to be made within it. Certain rules for cleanliness should be posted and enforced. The butchers may supply their own men to do the slaughtering, or one man may have the contract. A city inspector should be present at all slaughtering to inspect the meat and to enforce cleanliness. Fees for slaughtering may be charged to pay the cost of maintenance, the size of the fee depending upon the total annual output of the abattoir. At the Grand Forks, S. D., municipal abattoir the slaughtering is done by owners, and the fees charged vary as 60 cents per head for beeves, 30 cents for hogs and 25 cents for sheep and calves.

The essential requirements in the construction and maintenance of slaughter houses or of places for killing or dressing of animals for food, include construction to provide for

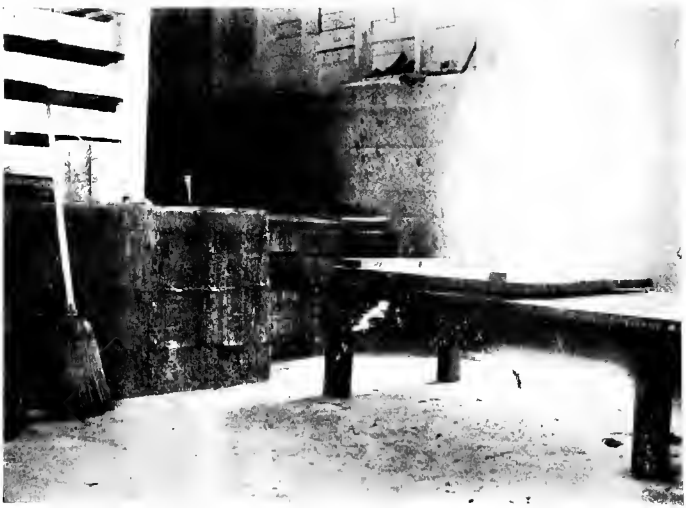
cleanliness; freedom from flies, rats and other vermin; a pure water supply; proper disposal of the offal; an entire separation of the live animals from the dressed carcasses; healthy employees and a meat inspector. The large slaughter houses of the principal cities, operated under federal supervision, are not herewith considered. It is the small butchering establishment as found in small towns and in rural districts which needs improving.

The small city or country slaughtering house should be established and located only upon the approval of the state and local health authorities. The site selected should be distant from residences, distant from water courses and located where prevailing winds will not waft odors where they may become a serious objection. The site should be high, well drained and isolated.

The construction should be of concrete or cement flooring, elevated and rat-proof. There should be no angles or corners of the floor at the walls where scraps may collect. Provision for washing by a hose, with drainage, is important. The windows and doorways should be screened to exclude flies. All construction around the scalding vats and other places should be of a design to prevent the accumulation of scraps of offal or of dried blood. No live animals should be kept in pens within the killing or dressing rooms, but should be provided with quarters entirely separated and remote from the rooms where the carcasses are handled or kept.

Cleanliness should be maintained by flushing with a hose after each day's work, washing the flooring and any part of the walls or shelving which may have become soiled. All utensils should be washed daily. The drainage from an abattoir within a city may be into the municipal sewer, provided there is no offal carried by the wash water into the sewer system. Where no large public sewer is available a special disposal plant for the slaughter house drainage is desirable. The wash water containing blood and small

OBJECTIONABLE SLAUGHTER HOUSE
Publicity and official condemnation forced reconstruction



The same hog-killing room three months later, photographed from the same position

particles of offal should not be drained directly into any water course. It should not be run off upon the ground or into any field with the expectation that the soil can take care of it without further attention. Such action will result in a nuisance, because after a while the soil becomes overloaded, a muddy puddle of putrid liquid forms and flies

SLAUGHTER HOUSE DRAINAGE CANNOT BE ABSORBED BY THE NATURAL SOIL. ATTENTION IS NEEDED TO PREVENT A NUISANCE

breed along its borders. The slaughter house drainage may be passed through a fine wire screen, which is frequently cleaned, and the comparatively clear fluid from the screen be treated to broad irrigation or intermittent subsurface drainage, as described in the chapter on sewage disposal. Under certain conditions of concentration it may be necessary to flow the drainage over a sand bed filter before the effluent is treated by other measures, as broad irrigation or possibly coke beds. If filteration is used the drainage should flow into trenches in the filter bed, the trenches having beds of sawdust. The sawdust retains

the decomposable particles and may later be removed and burned, according to the plan of Tolman.

The solid wastes produced in the small slaughter house consist of the hair, intestinal contents, bones and offal proper. These should be kept separate. The hair may become a by-product, marketable for mattresses and plastering. The contents of the stomach and intestines may

PILES OF DECOMPOSING OFFAL ARE OBJECTIONABLE FEATURES AT SLAUGHTER HOUSES

be used for fertilizer. Neither the offal nor the manure should be stored near the slaughter house, but should be removed daily. The offal should not be fed to swine but may be buried, burnt or converted into fertilizer. Hogs fed offal from ordinary slaughter houses are especially apt to develop tuberculosis. Hogs fed upon offal should not be slaughtered for public sale.

Guarding Oyster Supplies. — In protecting the public against the dangers of oysters spoiled by sewage, by adulteration or by infection, efforts should be taken to guard the

oysters until they reach the consumers. Legal enactments and personal supervision will provide safe oysters. Oyster beds should be guarded against pollution by sewage. Where endangered, sewer outfalls should be so situated as to make pollution of the beds impossible or the beds should be removed to safe harbors. The effective treatment of sewage before being discharged into waters near oyster beds should be considered or insisted upon. The plans to be adopted for protecting oyster beds become local questions. The "floating" of oysters in sewage-laden water should always be prohibited. The "floating" of oysters in fresh natural waters is nearly always a dangerous proposition. Oysters should not be shucked by any person who has had typhoid fever; the typhoid history of all persons opening oysters in canning factories and restaurants needs investigation. The addition of any water to the liquor of opened oysters, being both an adulteration and a danger, should be prohibited and prevented.

There are many excellent harbors along our coasts well adapted to the growing of oysters, clams and scallops, but yet untouched.

There can scarcely be an arbitrary standard test to be made upon oysters for the condemnation of oyster beds. The finding of colon bacilli within oysters evidently indicates pollution, but condemnation proceedings should be begun only after a thorough study of all the problems involved, together with a consideration of the recurrent danger of sewage pollution, as studied on the grounds, the effects of boats traveling regular courses, the effect of seasonal changes upon the water conditions, of flood waters and varying tides. The contamination of oyster beds may come from boats which can be controlled in their direction of passage or in their arrangements for sewage disposal. An alteration in the plan of municipal sewage disposal, as an extension of the sewerage system or a relocation of the outfall, may save the more valuable oyster bed. The

adoption of efficient methods for sewage treatment may suffice. A study of the grounds may reveal that a single household furnished all the colon bacilli found in the tests. The remedy for this condition is apparent. It may be determined in the field survey that the pollution is seasonal, as due to the prevailing winds of one season blowing the waters and their pollution from some particular direction. Where this state prevails, dredging of oysters during this time should not be done; and after a storm coming from the same direction all dredging and tonging should be stopped for a period of at least two weeks after these storms have passed.

Foods in the Home. — The care of foods in the home is no less important than their care in the market. This attention begins with the architect. Every house builder should provide properly located divisions in the cellar for the storing of foods, as fruits and vegetables, and provision should be made for locating refrigerators where they may conveniently be reached but protected from the heat of the kitchen and the sunshine, and not too exposed to freezing winter temperature. Underdrains for house refrigerators should be provided, trapped and convenient for cleaning. Refrigerators built with the ice compartment opening outdoors have an added convenience.

The housewife should not only study the better preparation of meals, the digestibility of various dishes and modes of cooking, the desirability of variety and the esthetic appetizing qualities, but also the better methods of storing foods. Milk should be kept within the bottles until needed. Pitchers and other containers for milk and cream should not be wiped dry on the inside after washing, but should be scalded and inverted to drain and dry. Flies, other vermin and cats should be kept away from all foods, dishes and cooking utensils. Refrigerators built to provide for a free circulation of air are the best. The coldest parts of these refrigerators are just beneath the ice and in the same

compartment with the ice. The colder parts of the refrigerator should be reserved for milk, cream, whipped cream, and fresh meat, particularly for liver, tripe and sweetbreads. Cooked meats need not be kept so cold. Opened bottles of catsup and salad dressing should be kept in the refrigerator. Butter and also lard should always be kept within the refrigerator. No canned goods after being opened should be kept in the can, even though upon ice.

Care of Foods on the Farm. — It is of the utmost importance that the food products intended for market, or for private use, should receive the greatest care on the farms of their production. Foods, of whatever nature, should be produced from healthy stock. Attention should be given that the stock does not become diseased. Diseased cows, diseased trees or diseased bushes produce deleterious if not dangerous products, and diseases become an economic problem as well as a hygienic one, since damaged goods command decreased value and diseases cause diminished production. The damaged and diseased stock should be treated and cured, or removed from the farm. Diseased animals should be removed from the herds and treated. Diseased plants should be destroyed or be cured. Profitless stock, whether animals or plants, should be weeded out. Efforts should be taken to determine which are profitable and valuable, and which are losses.

The prevention of diseases should be exercised toward the food-producing stock of the farm. These efforts include the vaccination of hogs, the testing of cows, the spraying of fruit trees and the use of Paris green and other poisons. The live stock should be furnished pure water from protected supplies. Plants should not be permitted to become infected by plant diseases nor to have their food products damaged or contaminated by disease germs or other substances deleterious to the health of the consumer. Those foods which are eaten uncooked should not be watered by house-drainage nor fertilized by human wastes. Such foods

which, growing near the ground, are contaminated by substances in or on the soil, as manure, include strawberries, celery, lettuce, cabbages, onions, radishes and spinach. Neither these nor potatoes, carrots, turnips, melons, cauliflower or berries should be fertilized by human manure. The decomposition of foods should be prevented on the farm as much as possible by the foods being stored under the most advantageous conditions.

Weights, Scales and Measures Inspection. — Weights and scales are inspected by testing with standard weights. Any weights found not balancing standard weights of the same face value should be condemned. Weights made of lead or made whole or in part of such substances which easily wear lighter, as wood or leather, should be condemned. A weight which does not have a distinct and permanent figure showing the correct number of pounds or ounces, as the case may be, should be condemned. Iron weights covered with scales of iron rust should be condemned.

Scales are tested for accuracy by standard weights. They should be required to weigh accurately. Spring scales having a very wide range of capacity are apt not to be correct. The movements of scales should be easy, responding quickly and uniformly. The bearings should be as near frictionless as possible, and be kept dry. Oils should not be applied, nor be necessary to exposed bearings. When the bearings are oiled the oil becomes gummy or collects dust, creating friction with misleading results. Some small, counter spring scales have an exposed regulating screw so placed that it can be manipulated by the salesman in an effort to give short weight. These or any scales which can or do give an opportunity for the salesman to defraud should be condemned. When inspecting scales they should be moved over the counter to discover any wire attachment which may extend through the floor. The fulcrum should be examined for the presence of any wedge, spring or other scheme intended to defraud. When

defective scales are found, they should be condemned and, when not correctable, confiscated; when any special appliance used with the intent to defraud is found, the owner should be prosecuted. Scales passing inspection should be marked with a dated metal tag; when condemned they should be confiscated or marked with a large red tag containing the word " Condemned " in different languages.

Measures are inspected and tested, but the inspection is not always sufficient. The inspections are made to discover irregularities in shape, the presence of dents, false bottoms or other conditions which would decrease the volume. Cylindrical measures should be cylindrical and not have the open top end compressed to an oval, thereby decreasing the volume. Metal measures which have compressed or dented sides do not give full measure. Square measures compressed to a rhombic shape are decreased in their capacity. Wet measures should not be substituted for dry measures for measuring dry substances as beans. The dry quart is over 16 per cent larger than the wet quart; the dry quart contains 67.20 cubic inches and the wet quart 57.75 cubic inches. Wooden or rusty iron measures used for measuring liquids should be condemned. The cylindrical measures without bottoms, which are used as funnels to put potatoes and other vegetables into bags, at the same time measuring them, I believe to be an advantage, although they are outlawed by some states. They are convenient and tend to give over rather than under measure. The increasing custom of selling all vegetables by weight in place of measure adds an extra burden upon the inspector. All vegetables sold by weight should be required to be sold free from dirt, leaves and other extraneous matter, and to be dry.

Liquids in bottles need inspecting in reference to full measure. Milk bottles may frequently be found short measure. A quart milk bottle should contain 32 ounces up to a half inch below the cap, and no higher. Various

bottled goods need inspection and the enforcement of the law should be prosecuted against the bottler and against the manufacturer of the bottles, and not against the retail jobber unless he is otherwise known to be guilty of the intent to defraud.

CHAPTER VII

CLEAN MILK

Upon the accomplishment of cleanliness and carefulness in the production and handling of milk depends the safety of the milk supplies and the prevention of many unnecessary deaths. The best results will come only after the public is better educated as to the value of pure milk, and the dairymen are instructed in the essentials of its production.

The natural purity of milk should be maintained as much as possible until the milk is consumed. Each period of its passage from the cow to the table needs careful watching and improving. But those to whom the care of the milk is entrusted should realize what is needed in each particular locality and how these needs may best be accomplished.

Before much can be sought in the improvement of a milk supply the total salient features of milk economics must be considered with the existing or probable local conditions. In order to obtain the cöoperation of the farmers their difficulties and expenses deserve consideration. The question of procuring and retaining satisfactory assistants, the question of feeds, the local farm influences upon crops and the intelligence of the dairymen are to be considered. Consequently, the inspector must needs know more than how to score dairies and stables. He should be thoroughly informed regarding dairy principles, and should be able to select those principles of advancement which are locally applicable, and should be able to explain how the various existing conditions influence the quality of the milk. Any work done to obtain improvements should be done in a gradual manner to avoid friction and resentment, the most important features being considered first.

There are two practical methods either of which can accomplish much in improving the milk supply. These methods relate to an enforcement of the law through the courts or, the better plan, to give the dairymen the advantage of first receiving instruction in hygiene. The dairymen may be taught by sending pamphlets through the mail, or the better plan, by personal talks. The dairymen, in small towns, may be collected at a meeting, or the better method is to visit each dairy farm and to explain to the owner the needs and their advantages. If dairymen are collected for an appointed meeting the talks may be generalizations or may specifically detail the needs of each farm. The latter are best judged by personal inspections, but much can be learned from laboratory examinations of milk samples.

The talks may be given with these tests as a basis. In giving any detailed talks the speaker should make each dairyman realize the exact conditions he maintains and the particular improvements he needs, but care must be taken not to let the competing dairymen know each other's faults. The speaker, after having made the preliminary inspections and examinations, can state that in a certain red barn where the separator stands between the rows of cows (or some similar description unmistakable to the owner), that here the flies swarm upon the dirty separator, hence the cream gives a bacterial count in the millions. Such references are convincing, and when the dairyman is told how to remedy his gross defects he realizes he is being watched and he learns the necessity of repair. The dairyman then learns the duties of the inspector, and the public soon appreciates the value of correct dairy inspection.

Dairy inspectors should supervise the entire course of the milk from the cow to the consumer, searching for unsanitary features occurring during the production and handling of the milk and making such practical suggestions as will eventually yield a purer, cleaner milk.

Inspections should be made with the view of obtaining

practical improvements. No person should attempt to inspect unless he is able to make such suggestions as the dairyman will follow. Practical suggestions should supplement criticism, and no dairyman should be asked to adopt those improvements which are clearly beyond his ability or intelligence to install and maintain. Suggestions offered should be simple and helpful, and their adoption be well within the financial and intellectual power of the dairyman. Such suggestions for the ordinary small dairy farm would include washing of the utensils and bottles, and a wetting of the udders and flanks of the cows before milking, as the most important improvements for the purely primitive dairy, and would lead up to keeping chickens and cats out of the dairy, a removal of all manure and a cleaning of the barn to prevent fly-breeding. The dairymen who are better able to buy needed utensils should be urged to use covered pails. Other improvements, up to installing autoclaves and brine milk coolers, are installed according to the wealth of the dairyman. The practical duty in dairy inspection is for the inspector to discover how much apparatus the dairyman is able to install and how capable he is of following directions, and then to explain the necessity of improvements and convince the dairyman of his needs and prove how he will profit by the improvements. General barn conditions can be noted at any time, but the dairyman should be present during the inspection to note the application of the suggestions. Since the chief points to consider in dairy inspection pertain to the handling of the milk, the best time to inspect a dairy is during milking time. The cows are then seen in their working condition. The plan and methods of milking, the care of the hands, the cleanliness of the pails, the place where the straining is done and the danger from flies can be noted. The inspector can see the straining cloth and demonstrate to the farmer the necessity of clean cows.

License should be a legal requirement for those who pro-

duce or handle milk or milk products for sale or for public consumption. A license should be granted only after an inspection and the necessary tests qualify the dairyman and his plant. The license should be non-transferable, renewed annually and revokable for legal cause.

HOW TO GET CLEAN MILK

Keep the barn as clean as possible throughout.
Don't feed the cows hay during milking time.
Brush the manure off the cows before milking.
Wet the udders with a wet cloth before milking.
Milk only with dry clean hands and clean clothes.
Do not put the fingers into the milk or cans.
Milk into good, clean and scalded metal pails.
Scald the pails and the cans just before milking.
Tie clean cheese cloth over the top of the pail.
Don't strain, separate or keep milk in the barn.
Cool the milk immediately and keep it cold on ice.
Milk only healthy cows. They should be tested.
Keep the milk away from flies, chickens and cats.
Use only clean, dry, fresh bedding for the cows.
If the barnyard gets muddy, fill it with gravel.
Do not handle the milk or the cows if you have recently had any infectious disease.

A Placard to be Nailed in the Dairy Barn

Placards are displayed in dairy barns as a constant reminder of the methods of accomplishing dairy hygiene and to induce the workmen to adopt cleanliness as a habit. Placards should be brief, legible and practical. They should be tacked where they may easily be read and remain permanently. They should include those directions and suggestions which the dairyman is apt to follow and should not entail any great expense for their adoption. The wording of the placards should conform to the amount of public work in dairy hygiene which has already been done in the community. If the work has just begun and the dairymen are not very far advanced in their ideas and practices simple

directions similar to the accompanying list will best serve the purpose. As the dairymen develop the factors of cleanliness and hygiene in their dairies, more advanced printed directions can be offered them as placards to be nailed in the barn. For these progressive men such a list as the "Twenty Dairy Suggestions" published by the Department of Agriculture would be applicable.

SCORING DAIRIES

There are two tangible methods of indicating to dairymen their standing as compared with their competitors and to show in written form the needs of a particular dairy farm. These are the score card and the inspection report. Whichever system is adopted by the inspector, he should leave with the dairyman a carbon copy of his records. The inspector's report shows only the defective conditions found, the suggestions which have been given and the improvements which were installed since the last inspection. The score card should show these and also give a general grading for the entire plant. The score card standardizes the dairy, placing it on a basis of a definite percentage of perfection. To the health officer, the inspector's report of a dairy's needs, the suggestions and the accomplishments, is of much more value than only a numerical score which does not show the particular needs or conditions.

Scoring dairies is done for the purpose of establishing grades of perfection to serve as goals for rivalry, and also for newspaper publicity for making comparison between dairies. Scoring is of little actual benefit to the health officer. In localities where dairymen will become rivals in attaining sanitary perfection at their dairies, the scoring is of great benefit. Where the dairymen are not inclined to improve matters just because a competitor has a higher score, the use of score cards is a wasted effort. Scores may be published in the papers as an incentive to induce the public to demand from their milkmen standards of clean-

liness, but scoring is not always opportune or effective. Where scoring is done the several local dairies should all be inspected and scored and then the names of the dairymen with their scores should receive publicity. Reinspection and rescoring are then done at unannounced and unsuspected visits and the results published. The scores of the last previous inspection should be included and published with the more recent scores, and instances of improvement be given special emphasis. Through this publicity the public learns what is needed and the negligent dairymen appreciate the necessity of making repairs. Where it is judged impractical to score dairies, publicity should be given those dairies which have instituted improvements, with details of the changes and their relative importance. This is especially applicable for small towns. The creditable dairies deserve more publicity than the neglectful, since better cooperation is obtained by tactful criticism and help rather than by harsh condemnation. In scoring dairies allowance should be made for the financial ability of the dairyman, and high scores given not alone to the rich, but to those who improve. After scoring according to the adöpted score card it would be advisable to give the dairy extra credit for those improvements established during a specified time, as, since the last inspection or during the past year, these credits being represented by their face values on the score card.

The score cards used in scoring and grading dairies, or any other establishments, should be complete and practical, exact in detail and without sliding scales or indeterminate factors. A score card designed for giving a sanitary score of a dairy should have the purity of the milk and not high-grade cows as the basis for consideration. The different particulars should be given weight in the relative importance they bear to producing a pure milk, the fractional grades being proportional to the causes which produce dangerous milk. An automatic ventilating system is

CITY MILK DEPOT SCORE CARD

Owner or manager Address
Permit No. Date of inspection
Number of wagons Number of customers
Gallons sold daily; milk , cream , gallons churned
On back make record of names and addresses of contributing farms.

Equipment.	Score.	Methods.	Score.
No barn within 500 feet	5	Clean yard	5
No open privies within 500 ft.	5	Clean utensils	10
Locality unsanitary.. deduct	5	Clean floor	2
Separate building	10	Clean windows	2
Part of residence	5	Clean walls	1
Grocery dairy	2	Clean ceiling	1
Cellar dairy	0	Flies none	10
No other business done	5	few	3
Salesroom separate	1	swarms ... deduct	20
Floor cement	5	Utensils	
tight boards	2	sterilized in autoclave	10
dirt	0	sterilized by steam	6
Walls cemented or painted	3	sterilized tank hot water	4
whitewashed	2	scrubbed	3
papered	1	only rinsed	1
Lighting good	2	Milk kept covered	5
natural or electricity	1	pasteurized in bulk	2
gas	0	pasteurized in bottles	5
Ventilation good	2	Kept 45° F. or below	10
Screens good	5	45° F. to 50°	3
broken	2	50° to 60°	1
none	0	60° to 70° ... deduct	10
Machinery:		above 70° ... deduct	20
bottle and can washer	4	delivered ice cold	10
milk cooler	10	thermometer used	5
bottling machine	3	cooler kept covered	3
capping machine	1	Men cleanly, healthy	5
pasteurizer	5	sterilized duck suits	2
cold storage plant	5	clean, dustless clothes	2
autoclave	10	hands clean	10
Water, purity known	5	no spitting on floor	4
Wash basin provided	2		
Individual towels	1		
Total score (maximum 100) Full credits given, or none.		Total score (maximum 100)	

helpful to the cows but scarcely comparable to the importance of the covered milking pail in the production of clean milk, yet their relative weights are equal upon most score cards. Too much leeway should not be given in scoring, leaving to the inspector to decide what proportion or fraction of 2 points should be accorded a certain condition; as, " tight sound floor and proper gutter." In these particulars the dairy score card, usually adopted, is faulty. The regular score card gives no credit to the man who builds a concrete floor in the barn.

The score card for dairy farms most used is that adopted by the Department of Agriculture, but I believe there are in it too many generalizations, too much room for favoritism or irregular scoring and that a revision of the values is highly desirable. The score card for city milk depots is offered as a practical suggestion, giving approximately the correct values for the various factors which influence pure milk. In the use of this latter card I would suggest that no fractions be used, each item receiving the full score or none.

THE SANITARY DAIRY BARN

The flooring of dairy barns should be the best that the dairyman is able to construct. Concrete floors are best, but where they cannot be built, as durable, tight and clean flooring as is possible should be used. When a new floor is to be built certain precautions should be followed; and when a dairyman must use a flooring already in place certain other sanitary precautions should be followed that the milk may be in the best condition.

Concrete floors are most satisfactory over dry or well-drained soil. Laid upon damp ground they are apt to be too damp and cold for the cows. If they are laid on soil not well drained, under-draining or side ditching will help keep the flooring dry and warmer. The concrete may be laid on a very heavy bed of large stones or upon a bed of tile or brick which will permit a circulation of drying air be-

neath the flooring. During winter the vents may be closed to keep out cold air, but the air space beneath the concrete adds warmth for the cows. The surface of the concrete should be comparatively smooth within the stalls, but in the run-way it may be roughened. There should be a slope of about one inch from the feed trough toward the gutter.

A PERFECT DAIRY BARN

The feed trough should be upon the level of the ground. Box mangers are unsanitary and dangerous, and should be abolished. They spread tuberculosis. The best feeding trough is a single long, concave, concrete trough supplying all the cows in the line. It is built without angles or corners. It is used for watering the herd; when empty of feed the water introduced at one end flows along the slightly sloping trough. Cows drink readily from it. The danger of diseases being transmitted along the trough is negligible.

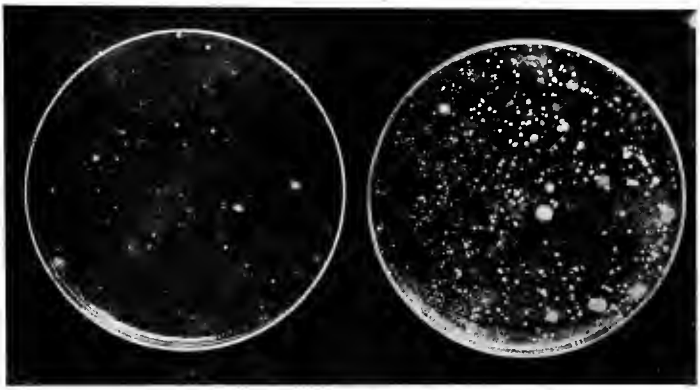
If the cows are fed hay, grating or boards may be built in front of the trough to prevent the hay being knocked beyond reach. These retaining boards should be made movable to facilitate cleaning the trough.

SANITARY, CLEAN, LIGHT AND VENTILATED; WITHOUT PARTITIONS, MANGER, OR DUSTY BEDDING

The proper feeding for a dairy herd is more a problem of economy than one of public health, the effect being a larger yield of richer milk rather than a cleaner and safer milk. But calculated balanced rations and uniform feeding produce a more uniform composition of the milk. In infant feeding uniformity is essential. There are certain plants

which produce objectionable tastes and which should not be given cows. Turnips and cabbage should be fed cows only immediately after milking. Cows should not be given any musty, moldy or decaying food. Swill and brewer's grains should not be fed to dairy cows as they damage the milk. Dairy cows should not be fed hay while being milked, as the dust produced will contaminate the milk.

The bedding provided a dairy herd should be as dustless as possible. It should not be too abundant and should be



SANITARY BARN *VS.* ORDINARY BARN
The germs which fell during fifteen minutes upon a four-inch circle in empty cow barns

changed frequently. No wet, damp or moldy bedding should be used. Dusty bedding damages the milk, as the cows in coming into a barn containing much dry hay bedding will raise a great amount of dust. The dust falls into the milking pail, contaminating the milk. To avoid this contamination, dusty bedding, as hay, should be used sparingly or not at all. Corn stalks and leaves make less dusty bedding, but none should be used as bedding after having been tramped over and befouled by the cows in the barnyard. Dried leaves make excellent bedding. For certified milk dairies nothing more than shavings or sawdust should be

used for bedding. Many dairy barns, with wooden or concrete flooring, use no bedding of any kind and are better without it.

Stanchions of almost any make are quite satisfactory for short usage. If the cows are kept all day or all night in the stalls the movable stanchions allowing good movement of the head are desirable. Every stanchion should be provided with a throat chain, which may be fastened across just before milking, to keep the cows standing after they are cleaned and are waiting to be milked. I am in favor of entirely omitting stanchions which hold the head and of depending upon short chains. A short, strong iron chain about twelve inches long may be attached to an upright iron bar or pipe by a large iron ring allowing free slipping. A single upright heavy 2-inch pipe or a pair of pipes, one on either side may be used. When two are used one is fastened vertically on either side of the cow's head, and between the two pipes is stretched a chain which slips freely up and down the pipes by its ring attachment. The short halter chain of the cow is hooked to this movable chain. The cow's halter is a chain worn around the neck with a branch chain and spring hook attached. The chain is probably more comfortable for the cow than any stanchion, and is much cheaper than patented stanchions. With the short chain, ring and iron bar arrangement the cow is not able to strangle herself as occurs with long chains or ropes attached to a fixed point, as at the front of a box manger. In using the iron bars if the lower end of the bar is fastened in the flooring twelve or eighteen inches in front of the upper ends, the cow upon lying down is forced to advance in the stall as the rings slip down the inclined bars, thus preventing her from lying in her droppings. To provide for this method of keeping the udders clean of manure, the chain bars are not fastened into the flooring vertically, but at an angle pointing in front of the cow.

Efficient ventilation of dairy barns is a precaution leading

toward a healthy herd and an increased milk supply. The system adopted for furnishing a supply of fresh air depends upon the size of the barn and the season. The fresh air should be introduced as an air current flowing toward the heads of the cows, thence flowing toward the back of the stall and exhausted from this locality. The King system is

RECONSTRUCTED BARN
Abundance of light and ventilation

best adapted for a barn with a low ceiling in which the herd faces away from the side wall. In this system the air is introduced through open windows which swing inwardly upon hinges at their bottom. The air is introduced behind the cows. blowing in with an upward current. It circulates throughout the barn, flowing to the heads of the cows, thence toward their hind feet and is removed through the vents behind the cows. The air vents are small openings

along the side walls, behind the cows and on a level with the floor, leading to tall flues or air ducts which open outside near the eaves or at twenty or more feet above the ground. In large barns with high ceilings there should be ventilators in the apex of the roof to remove the hot air which collects at the top.

Barns should be well lighted. In barns housing one or two rows of cows it is advisable to have at least four square feet of window space per cow. In wide barns having four rows of cows as much of the sides of the barn should be in windows as possible. The windows should be kept clean. The entire interior of the barn should be whitewashed twice a year, for both the sanitary and lighting effect.

Old barns may be reconstructed and made sanitary. All partitions and mangers should be removed, the stalls being separated by nothing more than railings, and shallow floor troughs be provided for feeding. Tight flooring is laid Windows may be cut in the walls. The ceiling rafters should be covered by sheathing with tongue and groove boards, or strips of heavy wrapping or building paper are nailed on with laths. This covering of the rafters is to prevent dust falling down from the barn floor above.

Manure. — The manure from dairy barns should be removed daily to a distance at least two hundred feet from the barn. The attendant should be careful to remove every particle and not to drop any in moist places. When removed this distance there is no opportunity for the milk to absorb any odors from a composting manure pile. The cowy odor of milk is caused much more from the manure which drops into the milk than from any absorption of odors. Flies breed more in cow manure than in any other substance commonly found on farms. Flies will breed little or not at all in drying manure. If horse stable manure is spread to be not over four inches in depth it readily dries and may be burned and all fly larvæ within it or upon the ground destroyed. Cow manure cannot so readily be dis-

posed of. Where practical the manure should be spread upon the fields throughout the year. Where this cannot be done it should be collected in a closed receptacle or tank which is both fly-proof and rain-proof, or it may be piled in the open. If piled in the open it should be in such a way as to be supported above the ground, permitting free air and dryness beneath. An iron rod grating is best for the under supports but planking supported upon logs, fence

INEXPENSIVE BARNS CAN BE KEPT CLEAN

rails or other uprights would be satisfactory. By this method the lower stratum will dry and there will be a minimum number of flies. Since rains dissolve the greatest proportion of the desirable fertilizing salts from an exposed manure pile, thus wasting the valuable parts, every manure pile should be carefully protected from the rains and snows. Manure should never be thrown into a pigpen, because it results in wasted fertilizer, concomitant fly breeding and discomfort for the swine. Hogs readily contract tuberculosis from rooting into or feeding upon manure which comes from tuberculous cows. A large proportion of tuberculous

cows pass virulent tubercle bacilli in their manure, even though the existence of the infection in the cows would not be suspected from their general appearance.

Milking. — Milking should be done with dry hands. If the hands are wet for milking some of the water drips into

STERILIZED MILKING SUITS, TAIL HOLDERS AND CLEAN BARN OF A CERTIFIED DAIRY

the milk, contaminating it. The filthy and dangerous practice of dipping the hands into the milk to get them wet for milking, and the equally reprehensible habit of spitting on the hands before milking are both dangerous and should be prohibited.

Clean clothing on the milkers is an added precaution for cleanliness in the milk. At the best dairies the milkers put on clean overalls which have been sterilized under steam pressure.

THE AREA FROM WHICH DIRT DROPS INTO THE MILKING PAIL
The hairs are clipped from the flank and udder of the cow to keep the cow clean

Wetting the udders before milking is the simplest and withal the greatest single measure for obtaining a clean milk. It is the first improvement for the health officer to accomplish by his dairy inspection. The inspector should impress upon the milkman the fact that the germs of milk which are objectionable come from the manure dropping

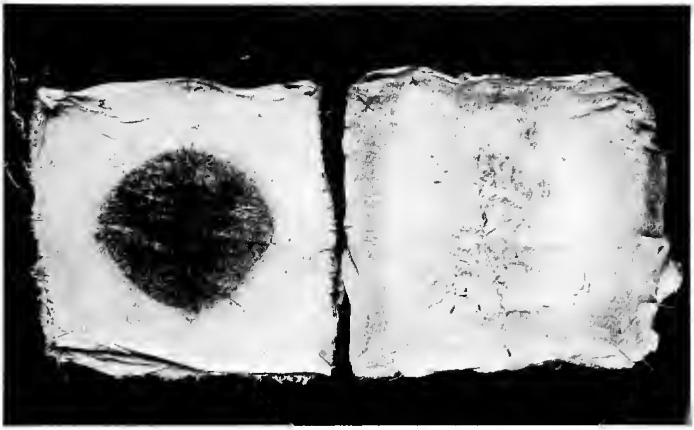
from the cow during milking, that the cow may apparently look clean but from the long dry hairs of the udder and flank innumerable germs fall into the pail, and that by wetting these hairs just before milking the dust and germs will adhere to the cow instead of falling into the milk. The dust of cow barns is a negligible factor until the cows are clean and dampened. Even fly contamination is of minor importance compared with the manure which drops from the udders. For wetting the udders dirty water and a dirty rag are better than no wetting, but the more cleanly the habits of washing the better. A clean piece of cloth, cheese-cloth or sponge, and clean unpolluted water may be used for wetting the entire udder, flank and adjacent parts. This should be done within five minutes of the time the cow is to be milked. If the cow is but slightly dampened she may dry and the effect be lost.

Clean Milking Methods. — Cleaning the cow to remove all visible dirt will greatly assist the wetting process. The cows should be scraped and curried, followed by vigorous brushing. In high-class dairies the entire cow is thus cleaned before each milking. Curry-combs or scrubbing brushes will remove the manure which cakes upon the cows. The long hairs upon the udders and flanks are cut short by clippers in the higher class dairy farms, since short hair can hold little dirt. Cutting the hair lessens the work of brushing and produces a cleaner milk.

The sanitary effect of brushing the manure from the cow and of wetting the udders before milking is shown in the photograph of the straining cloths used by a dairyman for straining the milk of nineteen cows. The first photograph shows the visible dirt which collected from the milk of a small herd of ordinarily clean looking cows; the cleaner cloth was that used for the same herd after the cows were brushed and the udders dampened before milking. The two cloths were collected by the writer upon unexpected visits, the second visit being made after a little personal

talk with the milkman. They clearly prove the value of dairy farm inspection.

The Covered Pail. — As an effective means to prevent the manure contamination of milk occurring during milking three variations in the form of the milking pail have been introduced. These are the covered pail, the narrow mouthed pail and the hooded pail. They were invented in this order. The covered pail is one having a piece of clean



THE EFFECT OF CLEANING THE COWS
The dirty cloth was that used for straining the milk from nineteen cows. The cleaner cloth was that used after the cows were brushed and their udders dampened

cheesecloth fastened on, covering the opening. The narrow mouth pail has the top decked over to restrict the size of the opening which is more or less horizontal. The hooded pail has a semi-conical cover which leaves on one side a small opening with a vertical diameter. The best milking pail would be a hooded pail fitted with a double metal ring over the opening, one ring slipping over the other and retaining over the opening a layer of sterilized cheese cloth. The hooded and small top pails materially reduce the size of the opening, decreasing the opportunity for dirt to fall

from the cow into the milk. The hooded pail is most effective, although milking into it is rather difficult. By covering the opening of these pails with cheesecloth the dust and bacteria of the air are excluded from the milk.

The covered pail is the greatest single improvement in dairy hygiene, excepting the washing of cows and utensils and the avoidance of milk-borne epidemics of typhoid. Health officers should make special effort to induce dairymen

THE MILKING PAIL COVERED WITH CLEAN CHEESECLOTH

to adopt some form of covered or narrow top pail. Where new pails cannot be purchased much can be gained in improving the milk supplies by getting the farmers to fasten over their ordinary pails pieces of clean cheesecloth. They should be directed to wash the cheesecloth after being used each time. If possible the cloth should be dipped into boiling water just before being used again. It may be held on the pail by twine or by a piece of wire. An octagonal or circular piece of cheesecloth may be used, a piece of heavy

wire be fastened to it by running the end of the wire in and out around the edge, or the corners of the cheesecloth may be weighted and the gauze be simply laid over the top of the pail. A spring wire, circular in shape, makes a convenient holder.

Milking pails and milk cans should be seamless, since any small cracks or seams retain a few drops of milk which sour and later contaminate the milk. Cracks may retain water which rusts the cans.

MILK STRAINED AND STORED IN A DIRTY BARN, AND COWS LYING IN THEIR DIRTY STALLS

The milk should not be strained in the cow stable where it is exposed to flies, dust and odors, but each pail of milk should be removed from the stable immediately after being drawn. It should be taken where it cannot be contaminated — to the milk room, or into the orchard or elsewhere, in the shade and away from dirt, flies, odors, chickens and cats. A box fastened on uprights off the ground, the opening overhung with mosquito netting, makes a practical and inexpensive milk house for temporary use. Warm milk

should not be kept in such a box longer than is absolutely necessary.

No separating should be done in the barn. The health officer should search for all milk apparatus kept under unsanitary conditions and cause their removal. Cream separating machines should be housed only in milk houses, and no other business or industry except that of handling or storing milk should be done in the milk house.

Separating milk in an attempt to remove the bacteria is not a practical procedure. The bacteria are closely associated with the fat globules, hence their removal by a separator cannot be accomplished without the removal of much of the cream.

Straining milk through a perforated brass or wire-mesh sieve does not make milk purer, and cannot accomplish much good in the public health efforts towards clean milk. Straining through cheesecloth is no more effective. The cheesecloth or metal strainer removes only the cow hairs and the larger pieces of straw and manure and permits the finer particles of manure and the bacteria to pass through into the milk. Since it is not the cow hairs and straw but the dissolved manure and the bacteria which contaminate the milk, straining the milk can do little good, but deceives the milkman into believing he is improving the milk. The straining deceives the customers also. If the method of producing the milk is so filthy as to get much manure into it, the purchaser of the milk has a right to know the quality of the milk he consumes. When the public knows that the milk is produced filthily the public will demand cleaner milk. Therefore the straining of milk through any kind of a strainer or sieve should be discouraged or prohibited. The health officer should use his influence and power to prevent this deception being practised by the milkman. The public should know that any dark sediment found in the bottom of bottles or cans of milk is cow manure, and that the richness of cream in milk is not so important as the freedom from

cow manure. Careless dairies producing manured milk should be avoided.

Milk bottles should be sterilized just before being filled. Sterilization in a steam autoclave is best. They may be sterilized by immersing in a tank of hot water into which steam is blown. They may be boiled. The use of any antiseptic substance in the water or in the bottle should be prohibited. A milk bottle may be quite efficiently sterilized by rinsing with one-third its capacity of boiling water. Scalding is but partial sterilization, but is much better than no hot water being used. A thorough cleansing of bottles with a brush and soap or cleansing powder, followed by at least four rinsings removes the greater quantity of the bacteria. When the bottles are collected by a dairyman the dirty ones should at once be cleaned. The public should be shown the value of clean milk and clean bottles, and their cooperation in thoroughly cleaning and scalding all bottles after use be sought.

Milk which is to be sold in small quantities should be delivered only in bottles. All milk so sold should be bottled at the farm, except where the milk of large cities is to be properly pasteurized under the permit, the supervision and bacteriological examinations of the local health department. Skim-milk and buttermilk should not be stored in or sold in containers which are not plainly, conspicuously and indestructably labeled in large letters "skim-milk" or "buttermilk," as the case may be. No containers should be used for any purpose other than that for which they are labeled and intended.

Paper bottles are made of paper and paraffined, or may be made waterproof by other methods. In a large city where the loss by breakage is excessive the adoption of paper bottles perhaps may be an economy. Paper bottles are used but once, not being removed from the house of the customer. They therefore do not have to be washed and sterilized. Their use prevents the transmission of disease

from the house of a customer to other families. Paper bottles are especially recommended for serving milk to the houses of sick persons.

Cooling the Milk. — Cooling milk immediately after it is drawn is the greatest safeguard in preventing the multiplication of its germs. Milk should be cooled as quickly as possible to check bacterial growth. It should be cooled

MILK COOLER AT A SMALL DAIRY COOLED BY WELL WATER

to 40° F. or below and kept at that temperature or lower until delivered to the consumer. That method by which milk is cooled most quickly and without exposing the milk to any adulteration or contamination, is the best. In large establishments the milk should be cooled by flowing over a series of zinc pipes which have been previously sterilized and then cooled by brine. On farms where refrigeration plants cannot be installed water-cooled milk coolers may be used if the temperature of the water of the regular supply

is sufficiently cool in summer to cool the milk below 50°. To operate the cooler with the regular water supply requires very cold water in very large quantities, but this method of cooling is feasible. Where conditions do not permit it and where ice in sufficient quantities can be had some form of cooler built to hold ice may be used. These funnel-

ICE-COOLED MILK COOLER

shaped coolers are filled with ice and the milk flows over the outside. Small rural dairies should not attempt to use any cooler in which the milk flows through the inside of a coil of pipe which is immersed in iced water. These coils cannot be readily cleaned nor effectually sterilized. Any cooler used should be so constructed that the milk flows

over the outside surface of the cooler, and this surface should be perfectly smooth and without rust and without angles or covers in which sour milk would collect. Before being used the cooler should be thoroughly washed and sterilized — washed by scrubbing, and sterilized by hot steam or boiling water. After being used the cooler is again washed and is entirely covered with a clean sheet or cheesecloth to keep off flies and dust.

Milk is not flowed over a cooler to remove from it any odors it may have acquired in the cow barn. Cowy odors in milk are due to the manure which drops in during milking rather than to the absorption of odors from the air. They should be eliminated by eliminating the manure from the milk.

Cooling by immersing the milk cans in a tank of water is not so rapid or effective as cooling in smaller bulk. If a rural dairyman sells milk by the bottle it is better for him to bottle the fresh warm milk and to stand these bottles in a shallow trough of cold water rather than to store the milk in large cans immersed in the same water. The bottles should be capped to exclude flies and dust. When the fresh milk is stored in large cans and placed in water to cool, frequent stirring of the milk or shaking of the cans by a rotary motion will facilitate the cooling. Without the stirring it may require an hour or two for the milk to cool. The water should not be splashed or poured into the milk. In milk houses in which the water tank is below the level of the floor the slope of the flooring should be in a direction away from the tank to prevent any dirt being washed from the floor into the water in which the milk cans are cooling.

Milk bottles can be used to serve in the pure milk campaign. The caps used in the bottles should be printed on top, "Keep covered" and "Keep on ice," besides having the name of the dairy and the day of the week. In the side of the bottle, in raised letters, should be inscribed the words "Keep on ice," and "Scald Bottle after Use," with the

name of the dairy and the amount of milk the bottle holds. The cooperation of the manufacturers of dairymen's supplies should be sought in the lettering of the caps and bottles.

Milk should be dated by having on the cap of the bottle the name of the day of the week. If the milk is pasteurized, the day of pasteurization should be the date used. For raw milk the day of production should be used. Milk coming on long hauls to large cities would be a day older by the dated cap than short-haul milk; this would be remedied by pasteurizing all the long-haul milk.

Night shipments of milk to the cities would get the milk to the consumers six to twelve hours earlier than will day shipments, therefore, dairymen should be encouraged to ship each night the milk of the same evening and of the morning of the same day. Railroads should be asked to cooperate for night shipments.

During transportation milk should be kept cold, and exposure to sunlight, dust and meddling be prevented. Railroad refrigerator cars should be provided. Bottled milk should be iced within the boxes. Padded canvas casings keep cold milk cool. Milk in cans should be covered with wet blankets when hauled in open wagons. Railroad freight platforms should be roofed.

Water supplies at dairies and milk depots should be investigated. The faucets where milk containers are washed should be out of the reach of children, and should be covered with a wire gauze guard. The purity of the water should be known. No bottle of milk should be totally immersed in any water tank for keeping cool, as cardboard caps are not water-tight and a dilution and contamination of the milk results. If a milkman keeps his bottled milk cool by standing it in water the overflow of the tank should be arranged to make it impossible for the water to get up to the tops of the bottles. Small bottles should be supported on racks to keep the capped or open ends out of the water. I found some typhoid cases to have received their infection

from the water in the cooling tank, the bottles of milk having been totally immersed in the water. A woman customer nursed her son with typhoid and infected the tank water with her hands. The tank water leaking through the cardboard stoppers contaminated the milk of bottles which were completely immersed. From the top of each bottle was a milkiness in the water, proving the bottles leaked. In inspecting rural dairy farms the health officer should note the source of the water supply. No water known to be polluted, or suspected of being probably polluted, should be used for washing the milk utensils. If the spring house or stream furnishing the water drains from the barnyard or pigpen, or if it receives the household waste from any nearby farm the use of the raw water should be prohibited. All wells sunk in barnyards, with rare exceptions, should be condemned as polluted and dangerous.

Any contamination occurring from nearby toilets should be prevented. Dairy farms should not be permitted to maintain open box-privies or other toilet facilities open to fly infection. Persons handling milk for sale should be shown the necessity of adopting habits of personal cleanliness; and employers should require, under penalty, their employees to be cleanly. Nobody who has had typhoid fever should be permitted to handle milk for sale unless it is bacteriologically shown that he is not a typhoid carrier.

Home Care of Milk. — The care of milk in the house is no less important than the care in its production. Housewives should be shown the proper handling of milk and milk utensils, and their cooperation be asked. If customers return dirty bottles to the dairyman they have no right to expect clean milk. It is their duty to thoroughly cleanse and scald every empty milk bottle before returning it to the dairy. When the bottles of fresh milk are received from the milkman they should be placed at once in the refrigerator or in the coldest available place. In the refrigerator the milk bottles should be placed next the ice,

touching it. If this is impossible, the bottom of the refrigerator, being the next coldest place, should be reserved for the milk. The milk should be kept in the bottle until used. The milk should always be kept covered to exclude flies and dust. Pitchers and other receptacles for holding milk should be scalded just before being used. After use they should be washed, rinsed and inverted to drain. They should not be wiped on the inside with a towel as this adds germs to the milk.

Home pasteurization of milk frequently becomes necessary in infant feeding and at other times. The pasteurization is done by placing the bottles of milk in boiling water. A pail having at least three times the capacity of the milk to be pasteurized, and as deep as the necks of the bottles, is filled two-thirds full of water. This is heated to boiling and the pail removed from the fire. The bottles of milk are placed in the water and left there not over fifteen minutes. They are then cooled as rapidly as possible and placed upon ice.

Thunderstorms sour dirty milk. Any milk which becomes affected by thunderstorms may be regarded as having had a very high bacterial count; and the dairyman who produces clean milk need not fear the storms. The souring of dirty milk by storms will occur within a cold refrigerator, and occurs very suddenly. The effect of the storms appears to be an electro-chemical overbalancing, producing a rapid formation of lactic acid at a time when the acid had already nearly formed. Air concussion, barometric pressure, changes in atmospheric humidity, lightning and ozone formation appear to have nothing to do with the souring. The souring is too rapid to have any connection with bacterial multiplication.

TUBERCULIN TESTING

Tuberculin is the sterilized and filtered glycerin extract of cultures of tubercle bacilli, containing their cooked prod-

ucts but not the bacilli. When injected under the skin it is absolutely unable to produce tuberculosis, to cause abortion or otherwise injure the animal (Mohler). If the animal is tuberculous a decided rise of temperature will follow the use of tuberculin. Its use detects the tuberculous animals, that they may be removed from the herd in the effort to eradicate the infection.

Tuberculin is not an absolutely infallible agent, but it is immeasurably more dependable than any other method that has ever been used. An accurate diagnosis may be established by it in over 97 per cent of the cases tested (Mohler). In an advanced case of tuberculosis having much natural tuberculin already in the system the ordinary sized dose used for testing is relatively so slight that no reaction may occur. A previous test of an animal producing a tolerance to the tuberculin, lasting for about six weeks, may cause a failure in the second test. In cows which are not tuberculous there may be an elevation of temperature as a result of advanced pregnancy, excitement of œstrum, concurrent diseases, as inflammation of the lungs, intestines, uterus, udder or other parts, abortion, retention of after-birth or other conditions. Inclosure in a hot, stuffy stable in summer, exposure to rains, or any change in the method of feeding, watering or stabling during the test are other conditions causing failure in the test. They should be closely observed and their influence correctly interpreted.[1]

Records of tested cows are kept upon small cards upon which is printed the profile outline of a cow, both right and left sides. Upon this outline the inspector notes the characteristic outlines of any markings the cow possesses as a means of establishing a positive identification, since no two cows are alike. The date and results of the test, the name of the owner and location of the farm and the breed, age

[1] Dr. John R. Mohler: *U. S. P. H. S. Hygienic Laboratory Bulletin No. 56*, 1909.

and color of the cow are also recorded. With this Bertillon system of identification the inspector subsequently may recognize a cow which he has condemned and which has been sold to another farmer.

DIRECTIONS FOR MAKING THE TUBERCULIN TEST

1. Stable cattle under usual conditions, feeding and watering in the customary manner.

2. Make a physical examination of each animal.

3. Take the rectal temperature of each animal at least three times at two or three-hour intervals on the day of injecting; for instance, at 2, 5, and 8 P.M.

4. At 8 or 10 P.M. inject a dose of tuberculin under the skin in the region of the shoulder, using a sterile hypodermic syringe, after disinfecting the skin with 5 per cent carbolic acid or with tincture of iodine. Tuberculin is not always concentrated to the same degree, therefore the dose varies, but is stated on the label. The dose of imported tuberculin is 0.25 c.c. for an adult cow, and, before injection, is diluted with sterile water to 2 c.c. The tuberculin of the Bureau of Animal Industry is given in a dose of 2 c.c., not to be diluted. Yearlings and 2-year olds, according to size, should receive from 1. to 1.5 c.c., while bulls and very large animals may receive 3 c.c.

6. At 6 A.M. of the day following injection of tuberculin commence taking the temperatures, continuing until twenty hours after giving the tuberculin.

7. A positive reaction would be indicated by a rise of temperature of 2° F. and one in which the temperature reaches at least 103.8° F. The temperature reaction should show the characteristic rainbow curve. A suspicious reaction indicates the need of retesting six months later.

STANDARDIZING MILK

For the purposes of more effectively classifying municipal dairies, their contributing farms and their milk products,

it is desirable to outline definite standard conditions to which the dairies should conform according to the condition of the milk they intend to produce. Standards are essential for legal enforcement when prosecution may depend upon the results of laboratory tests. I am in full accord with the New York Milk Committee in recommending their classification to be applied to milks of large cities. Small cities and towns should adopt a higher standard for the bacterial counts of Class B and Class C milks.

The New York Milk Committee Standards[1] are as follows:

Class A. — Certified milk or its equivalent.
Class B. — Inspected milk.
Class C. — Pasteurized milk.
Class D. — Milk not suitable for drinking purposes.

Class A. The term certified should be limited to milk produced in conformity with the requirements of the American Association of Certified Milk Commissions. Milk termed equivalent is that produced at dairies subjected to periodic inspection and the products to frequent analyses. The cows must be properly fed and watered, be free from tuberculosis as shown by the tuberculin test and veterinary examinations, and be free from other diseases and conditions which would deteriorate the milk. The cows must be kept clean and housed in clean, ventilated stables. All persons coming in contact with the milk must be free from typhoid fever, tuberculosis, diphtheria, scarlet fever, septic sore throat and other diseases which may infect the milk. Pure water must be provided at the farm. The milk must be drawn under all sanitary precautions to prevent contamination, be immediately strained and cooled, placed in sterilized bottles and kept at or below 50° F. It shall contain not over 10,000 bacteria per cubic centimeter.

[1] Report of the Commission on Milk Standards, Reprint, *U. S. Public Health Reports No. 78*, 1912.

Class B. Inspected Milk. — This class includes clean raw milk from healthy, tuberculin-tested cows and from dairies that score not less than 70 on the Government score card. The cows are fed, watered and milked under good conditions. The dairymen must exercise cleanliness and be free from diseases which may be milk-borne. The milk is delivered in sterilized containers and kept at a temperature not greater than 50° F. until it reaches the consumer. It should contain less than 100,000 bacteria per cubic centimeter. Pasteurization is optional.

Class C. Pasteurized Milk. — Milk from dairies not able to comply with the A and B requirements should be pasteurized under official supervision, and then sold as "pasteurized milk." Milk for pasteurizing should be kept at not over 50° F. while in transit to the plant. After pasteurization, it is cooled at once to 50° F. or below and maintained there. No cows in any way unfit for the production of milk for use by man shall be permitted to remain in any Class C dairy. The milk before pasteurization should contain not over 1,000,000 bacteria per cubic centimeter, and not over 50,000 after pasteurization. It should not show colon bacilli in one cubic centimeter. It should be delivered to the consumer within 48 hours after pasteurization. Repasteurization is prohibited.

Class D. Unfit Milk. — Milk containing over 1,000,000 bacteria per c.c., or from farms scoring less than 40 per cent may be allowed for cooking and industrial pusposes only after being pasteurized or heated to a higher degree. It is delivered in distinctive containers and cannot be sold for drinking.

Certified Milk. — Certified milk is milk which is produced under certain hygienic requirements, meeting certain high standards of purity and receiving a certificate of proficiency from the local medical society. Guaranteed milk is not certified milk. A guarantee which is given by the dairyman means nothing. Dairymen should be legally

prohibited from applying the term "certified" to their milk products unless the local medical society actually does certify the milk after making the necessary inspections and tests. Certified milk necessarily demands a very high price owing to the great expense requisite for its production.

The standards for certified milk include as the maximum permissible bacterial count 10,000 per cubic centimeter for milk and 25,000 for cream. Variations in the fat content must not be greater than one-half of one per cent from the declared or advertised fat content. The Medical Milk Commission of the Philadelphia Pediatric Society also includes the following required standards: Specific gravity between 1.029 and 1.034; reaction, neutral or faintly acid; proteid between 3 and 4 per cent; sugar between 4 and 5 per cent. Chemical and bacteriological examinations are made of the certified milk at frequent intervals. The requirements for the sanitary production and handling of the certified milk are specific and exacting, specifying in minute detail the various procedures of dairy hygiene which must be followed. This use of the word "certified" as applied to milk and cream should be protected by law.

The certified dairy produces a milk which will keep fresh and wholesome many days. Such milk is produced under the most sanitary conditions. The milking house is a one-story, frame and concrete building, located far from a public road or railroad. The concrete floor is swept and washed daily. The stalls are separated by a single iron pipe post, without partitions. The windows, entirely covering the walls, are washed frequently and kept open on the hinges attached at the bottom. The cows are admitted to this house only during the milking period. While in this shed they are fed only bran or ensilage, and are watered from the concrete floor trough. Healthy, medically inspected and intelligent milkers enter in white sterilized duck suits and caps. The cows are groomed, curried and brushed from the head to the end of the tail. Within the past year

the cows have been tuberculin tested, and within the past month examined by a veterinarian and pronounced free from all disease. The udders and flanks, from which the hairs have been clipped, are washed with a sterilized sponge and clean water. The milkers, after thoroughly scrubbing their hands with soap and water, milk the cows into sterile cheesecloth-covered, small-top metal pails, the cows being kept standing by throat chains and their tails retained in tail holders. The milk is weighed, strained through sterile cotton, cooled to 35° F. over a brine-cooled cooler, and bottled in sterilized bottles within ten minutes of the time it is drawn. It is stored, shipped and delivered ice cold. Such is the production of a high-grade milk, having a bacterial count of less than 5000, and frequently with less than 1000 bacteria per cubic centimeter. The highest class dairies observe all these precautions.

I am in favor of prohibiting, by city ordinance, the use of the word "sanitary" in the name of any dairy or its product, or in the name of any market or other food store.

Pasteurization. — The need of pasteurization of a city milk supply is considered according to the size of the city and the length of railroad hauls for the milk. For most large cities the supplying dairy farms are located at great distances requiring many hours en route for the hauls. In such large communities where the health conditions of the dairymen and the sanitary conditions of their dairies cannot be under practically constant observation and control, where tuberculin testing of cows cannot be enforced, and where hygienic improvements are not made, the pasteurization of all milk, except certified and specially inspected milk, should be a legal provision. This applies to our largest cities. For small cities the need of pasteurization varies with local conditions. Certified milk should not be pasteurized. No milk should be repasteurized. Pasteurization does not make unnecessary the inspection of milk shops, dairies or creameries. It should not indiscrimi-

nately admit dirty or stale milk, since filthy milk cannot be made pure by any amount of pasteurization. Pasteurization is simply a final adoption as a means to overcome dangers which cannot be foreseen or controlled, and even with pasteurization dairy inspection and dairy hygiene must advance.

Commercial pasteurization is done by one of two methods. One is known as the "flash" or "continuous" process in which the flowing milk is heated to 160° or 165° F., and held there only from one-half to one minute while it flows onward. The other process, the more desirable and effective, is the so-called "holder" or "holding" process in which the milk is heated to 140° or 150° F., and held at that temperature for approximately thirty minutes. The flash process is usually unsatisfactory, as the tubing and other parts of some machinery cannot be sterilized, and the treated milk may show a higher bacterial count than the raw milk. In either process, after the heating, the milk flows over the cooler where it is cooled to about 40° F., and is immediately bottled. The better and more recent holder pasteurizing plants bottle the raw milk, pasteurize it while bottled and cool the bottles by a blast of cool air. Milk pasteurized within the bottles is free from any possibility of reinfection until it reaches the consumer, unless contamination is allowed to leak in by a wet or loose paper cap. The New York Milk Committee recommended that the temperature limits for pasteurizing should be 140° and 155° F. At 140° F. the minimum exposure should be 20 minutes. For every degree above 140° F. the time may be reduced by 1 minute, but in no case should the time be less than 5 minutes.

Rules for the guidance of pasteurizing plants, as recommended[1] by the Commission on Milk Standards appointed by the New York Milk Committee, require that: The milk should be cooled to 60° F. or below within two hours after

[1] *Public Health Reports*, May 10, 1912.

being drawn from the cow, and held there until pasteurized, after which the temperature should not exceed 50° F. The milk shall not be adulterated. It shall not be tested by tasting in a way that may contaminate it. It shall be bottled only in licensed plants. It shall be delivered in bottles, excepting that establishments consuming or using it on the premises may receive milk in bulk of twenty quarts or more. It shall not be stored in or sold from a living room or other place which might render it liable to contamination. Pasteurized milk should be labeled as such, together with the temperature and shortest time of pasteurizing, with the date. Pasteurizing plants shall be clean, well-screened and lighted and shall be used for no other purpose than the proper handling of milk, and shall be open to inspection by the health officer at all times. They shall have smooth, impervious floors, properly graded and drained. They shall be equipped with hot and cold water and steam. Ample provisions for steam sterilization shall be made, and no empty milk containers shall be sent out without sterilization. All utensils and apparatus shall be sterilized daily.

For smaller cities and towns a provision may be made for pasteurization to depend upon the length of time required for transit to the city, the temperature of the milk while in transit being considered. Pasteurization may be required for all milk reaching the city at a temperature above 75°, as an example, and after being en route over six hours, or other selected time or temperature as is believed advisable under local conditions of season, latitude, population or other factors. Such requirement should apply to milk without regard to the means of transit, whether railroad, wagon or boat. In some towns it may be advisable to erect centralized pasteurizing plants.

Centralized pasteurization plants are those situated central to the various dairies supplying the milk and centralized to the district of the customers supplied. Where they can

be established they are of great service as all milks brought to the town are required to be pasteurized in them and to be distributed from them. The milks distributed from the central stations are equal in quality and purity, therefore the local community supplied may be districted, each district to have its milk delivered from a single wagon. Where dairymen can be induced to adopt this plan the great expense of time and labor which is wasted in long and overlapping hauls, when many different wagons supply the same block of houses, is practically overcome. This centralized distribution is only applicable when all the milk of the community passes through the central distributing plant and when the public is shown that the milk to be carried to one section will not vary from that which another locality receives.

Collecting Stations. — Rural cooperative central collecting stations are desirable. With this system all the surrounding farms in a convenient area deliver their milk to the collecting plant from which it is shipped to the city. The system is patterned after the system of collection adopted by rural creameries. The collecting plant is a high-grade bottling plant, also equipped with means for sterilizing bottles and cans. The farmers, immediately after milking, take their milk to the bottler, who washes and sterilizes the large cans which the farmers take home. The bottler cools the milk, over a cooler or with ice, to 40° F. and bottles the milk or keeps it in the sterilized forty-quart cans. Each evening the collector ships, in refrigerator cars, the milk milked the same evening and the morning of the same day. Where this system is inaugurated there is a great saving to the farmers by reducing expense of delivery and bottling, and higher grade milk reaches the consumer. The milkers should use small top milking pails, the opening of which is covered with a cap. These pails are taken daily to the sterilizing plants to be washed and sterilized. The straining of the milk by the farmer should be forbidden, to permit of

reliable sediment tests being made. If the milk is to be pasteurized this central collecting station may be the pasteurizing plant. This centralization requires but one bottling apparatus, one washing and sterilizing equipment and one pasteurizing plant to serve for many dairymen. The pasteurized milk should be shipped to the city in bottles, and not in bulk.

Bacterial Standards. — Bacteriological standards for milk are the most practical laboratory standards. Tests for adulteration are made from the economic standpoint; purity in milk as shown by chemical tests does not necessarily indicate safety. Bacteriological standards should be established locally; as, with nearly all other standards, a single standard is not universally applicable with fairness, justice and safety. The standards adopted by different cities for the control of their milk supplies vary usually between 100,000 and 500,000 bacteria per cubic centimeter as the maximum limit for ordinary market milk. For purposes of authoritative condemnation a bacterial standard is valuable, although a bacterial count alone tells little and does not determine the entire safety of a milk. It is sufficient to state that milk showing excessively high bacterial counts are to be avoided, and dairies producing them should be detected and improved. The bacterial count of milk detects carelessness in the production and handling of milk but gives little information as to the danger of the milk producing definite disease. The disease-producing organisms are difficult or almost impossible to detect. When a milk supply has transmitted some specific disease, as typhoid fever or diphtheria, by the time the cases begin to appear the actual lot of milk which conveyed the infection has been used up, therefore any bacteriological examination in the search for the specific pathogenic organisms is useless. Bacteriological examinations serve as a check upon the work of the dairy inspectors; dairies receiving high rating usually produce milk with low bacterial counts. The inspectors

should be checked up, not so much for their efficiency as to discover things they have overlooked.

Suspiciously low bacterial counts may indicate the advisability of testing the milk for preservatives. No preservatives of any kind should ever be added to milk. The use of preservatives should be prohibited and the laws rigidly enforced. Chemical tests for preservatives not only detect fraud but reveal hidden sanitary dangers.

Chemical Standards. — Chemical standards are of value in preventing the grosser forms of adulteration and fraud, but are of but slight sanitary significance. The United States standards for interstate traffic provide (1915) that milk shall not contain less than 3.25 per cent of butter fat, nor less than 8.5 per cent solids not fat. Cream shall not contain less than 18 per cent butter fat, nor skim milk less than 9.25 per cent solids not fat. The New York Milk Committee recommended these Department of Agriculture standards, but many states and cities vary considerably from these in their legal requirements.

Rating a City Milk Supply. — It may be desirable to rate the entire milk supply of a city for purposes of comparison

METHOD OF RATING A CITY'S MILK

Bacteria groups.	Number of samples	Rating figure.	Product.
Under 10,000	17	100	1,700
10,001 to 50,000	22	90	1,980
50,001 to 100,000	68	75	5,100
100,001 to 250,000	34	50	1,700
250,001 to 500,000	26	20	420
500,001 to 1,000,000	12	10	120
Over 1,000,000	4	0	0
Total	183		11,020

$$\frac{11{,}020}{183} = 60.2, \text{ average rate of entire city supply.}$$

with another city or for citation in the annual report to indicate the yearly variations. For this purpose the Levy

method of stating results may be used. The bacterial counts as shown by the various milk supplies are grouped according to the American Public Health Association classification. Each group is given a special rating figure. After tabulating in their specific groups all the bacterial counts of all samples of milk examined, the rating figure of each group is multiplied by the number of samples of milk of that group. The various multiplied products of the rates with the number of samples are totaled, and the result is divided by the total number of samples of milk counted. The quotient is the average rate figure for the entire milk supply, as illustrated in the table.

MILK OUTBREAKS OF DISEASE

Milk-borne diseases are those diseases the germs of which are carried in the milk supply. The diseases most liable to be milk-borne are typhoid fever, septic sore throat, scarlet fever, diphtheria, bacillary dysentery and tuberculosis. Various bovine diseases could be transmitted through the milk. The diseases which usually occur as sudden outbreaks from some special infection of the milk supply are typhoid fever, scarlet fever, septic sore throat and perhaps diphtheria.

The infection of the milk by the specific organisms of these diseases may occur at any time after the milk leaves the cow. The milking pail or milk bottles may have been washed in polluted water or handled by contaminating hands. The milker, dairyman or some assistant handling the milk may directly infect the milk by his infected fingers, or he may cough or sneeze the germs into the milk or into a milk utensil. Some one who handles the milk or some utensil or apparatus with which the milk comes in contact may have nursed or touched some one who has had one of the transmissible diseases and who is still infectious. The milk or utensils may be infected by flies coming from a sick room or from an open privy. Milk bottles may have been

left at a house containing some person ill with one of the diseases, and have been infected therein. In each instance where an infection is believed to be milk-borne the endeavor should be made to establish the specific manner in which the milk became infected.

Milk outbreaks of a disease will show a special preponderance of the cases upon some certain milk route. The routes of the dairymen supplying milk to the infected families should be mapped out on a map on which is spotted the cases of disease. That supply along whose route the greatest number of cases occurs is suspected as causing the transmission. An immediate inspection of the milk station is made and all employees carefully questioned regarding their present and past health, their habits of visiting people who may be sick and also relative to the condition of each member of the families. The habits of the men are watched, and the location and arrangements of the toilets noted. The prevalence of flies and other insects and their possible infection of the milk or utensils, and the presence of cats, dogs, mice and chickens are all investigated, but there is little, if any, danger of these animals causing any specific disease.

Milk-borne typhoid attacks those who drink milk, and is usually more common among those under ten years of age than those of the twenty-to-thirty-year decade which is the period most susceptible to typhoid. When the typhoid morbidity rate is high among children the milk supplies probably need special attention, even though there be no special outbreak. Even if some precautions have been taken respecting the milk supplies added efforts or a change in methods may be needed.

Milk outbreaks are explosive in character, a large number of infected persons appearing suddenly and the later cases following in rapid succession. This is due to the fact that a certain can or lot of milk receives an amount of the infective material from contact with an infectious person

or through water or other means. This one lot of infected milk is the transmitter of the disease and since it is consumed in one day those infected begin their incubation periods upon that date. The variations in the power of inhibition of people prevent all the infected persons developing fever upon the same day. Any cases of the disease appearing after the maximum period of incubation are regarded as secondary cases. They either contract their infection by direct transmission from the previous cases or by secondary milk infection.

Secondary milk infection occurs by the new milk being poured into infected vessels. After the milk was primarily infected and delivered to the consumers, the milk pails, cans or bottles which had come in contact with this milk may not have been thoroughly sterilized. Any milk later added to these infected vessels will become infected from the remaining pathogenic organisms — in few numbers, to be sure, but capable of multiplying very rapidly if the milk is permitted to get warm. Since this secondary infection will occur the next day after the primary infection has happened, and since the cases of disease do not begin to appear for several days or two weeks later, the secondary infection of milk by previously infected milk cans cannot be prevented except through a system of dairy inspection and milk hygiene which has been in operation for some time past.

Subsequent infections of this milk supply are preventable. These infections are due to a continuous or intermittent infection from the original focus or to an infection of milk bottles within the infected houses of the consumers. It is to prevent these infections that special dairy inspection and milk control should be commenced immediately after the beginning of the first reported cases of the disease. This work must be done thoroughly and rapidly, and in about the following order.

The health department should placard each house con-

taining cases of the milk-borne disease. These placards, posted in conspicuous places at both the front and rear entrances, declare that the disease exists within the house, and that no glass milk bottles are to be left at the house and no empty bottles then within are to be removed until further orders. The householder may place on the doorstep a pitcher into which the milkman may empty his milk, but the householder is forbidden to receive any glass milk bottles. Milk may be delivered in paper bottles which are not removed from but are destroyed in the house. It is unsafe for any glass bottles to be left owing to the possible danger of some being thoughtlessly taken away, or of some bottles not being actually sterilized after the termination of the quarantine. The dairyman is also furnished, by printed postal or written order, the name and address of the infected household and warned not to go into the house or to leave milk bottles therein.

At the dairy the health officer orders complete sterilization of all milk bottles, cans and other utensils used for holding milk, and he should personally see that the orders are obeyed. The complete and thorough cleaning is done on two or more successive days to include the entire lot of bottles and cans in circulation.

In investigating milk epidemics some of the points to receive consideration are the following:

1. The number of cases of the disease in the involved territory during the outbreak; and the number of cases occurring during the previous months, compiled for comparison.

2. The name, age and address of each of the epidemic cases, together with the dates of the beginning of their fever.

3. The name of their milkman; the amount of milk consumed and the names of the individuals drinking milk.

4. The number of houses involved; the number of adults,

of children, of well people and of cases of the disease in each house.

5. The number of houses supplied with the suspected milk; and the number of other houses in the same territory receiving milk from other dairies alone.

6. The names and addresses of dairy farms supplying milk to the dairy which distributes the suspected milk. The names of the dairies or milk depots receiving milk from each of these dairy farms.

7. The location of the case or cases from which the milk received its infection, together with the dates of the beginning of fever and the termination of each case.

8. The particular relationship these original cases had to the involved milk supply.

9. The methods taken to eliminate other common carriers as the cause of the outbreak.

10. The effect upon the outbreak by closing the dairy or the taking of other detailed measures to check the further transmission of the infection.

CHAPTER VIII

WATER SUPPLIES

The protection of public water supplies has received a greater total expenditure for its development than have nearly all other agencies which promote the public health. This prevention of the pollution of water, with the final destruction of such polluting substances as are emptied into water courses, is partly the result of an esthetic demand and largely the result of the demonstration that typhoid fever receives a great check by this means. The public has learned to dread typhoid fever, and hence to demand its elimination. The need of protecting water supplies is almost universally understood, as the damage from polluted water resulting to health, to comfort, to industry, to commerce and to realty is publicly realized. Pollution of waters by sewage or factory wastes creates a nuisance from which people shrink and for which there is legal redress. The damage resulting from disregarding the effect upon waters created by the obnoxious substances discharged into them has been enormous. This defiling of the rivers and bays has markedly decreased the supply of food fish, has damaged the shellfish and indirectly has been a factor in the decrease of wild birds. The greatest effect of polluted water has been upon health. Sewage contaminated water does not necessarily always contain the germs of typhoid fever, but where such water is used for domestic purposes typhoid is apt to be rife, either endemic or constant, or epidemic or intermittent. The prevention of the domestic use of water containing sewage pollution markedly reduces the death rate from typhoid fever and is a strong factor in reducing the general death rate as well as the

rate from intestinal diseases, of infant mortality, tuberculosis and other diseases whose fatality is augmented by debilitating influences.

The advisability of first installing a public water supply or of laying sewers in small growing towns is a mooted question. The public water supply is probably the one usually adopted first. It is the improvement affording the greater convenience. The relative cost of a public water supply and of sewerage is usually somewhat greater with the former. The initial expense is considerably greater in constructing water-works. Almost without exception, it is of greater value and necessity for a growing town to build public sewers before laying water mains.

The money and conveniences to householders should not be the deciding factors; the effect upon the public health is paramount. Questions to be decided, before selecting between a public water supply and sewerage to be installed, are the prevalence of typhoid fever in the town; the purity of the contemplated source of water supply; the safety to others affected by the proposed discharge of sewage; the usual cleanliness maintained in the yard toilets; and the practical control of fly infection. If the town keeps free of typhoid fever and the strict purity of the proposed water supply is not assured, the laying of sewers would appear a greater need than a water supply, for safety. If there is usually more or less typhoid present and the proposed outfall of the sewer would be into a stream which later supplies another community, their lives should not be endangered; but a public water supply should be installed, also other measures, as effective control of the milk and food supplies, with educational work to urge upon people more typhoid immunization, to the end that the typhoid fever may be eliminated. If the private wells in the village are deep and surface privies rather than cesspools are used, the private water sources may continue to be used for awhile and public sewerage be built. Then

the typhoid infection may be fought through milk, food, flies and careless handling of the sick rather than by too strongly condemning the suspected water supplies.

Guarding Watersheds. — Policing or patrolling watersheds constitutes an effective way of assuring greater purity in public water supplies. Frequent inspections may be made of every house or habitation upon the watersheds, instruction given where needed and legal enforcement where required. No sewage, manure, household wastes, wash water, or animal or vegetable matter whatsoever, in the raw state, should be permitted to be directly discharged into any stream on a municipal watershed the water from which is used untreated as a domestic water supply. Human discharges containing germs of dangerous diseases should not be so deposited that they can be carried by rain, melting snows or floods into such water. In patrolled watersheds no bathing in the streams or lakes should be permitted; no garbage be permitted to be thrown into the water or deposited within five hundred feet of it; no camping allowed; necessary labor camps be rigidly inspected and controlled. No hunting by visitors is permitted on patrolled watersheds; all cases of infectious diseases should be rigidly guarded and controlled. All typhoid cases should be removed immediately from the patrolled watershed. The use of properly located and drained cesspools rather than surface privies upon controlled watersheds should be encouraged.

PRIVATE WATER SUPPLIES

The conditions of individual water supplies as used by farmhouses, resorts, hotels, mills, country homes and other establishments not connected with municipal systems need investigating. Conditions may be satisfactory, but the safety of a supply or the dangers which may arise should be known. Private water supplies, no less than those sources used by municipalities, need protection — both

cleansing and guarding. Individual springs, wells and streams produce their effect upon a small scale, but since half the typhoid fever is of rural distribution the total effect of these small sources may be realized. Considering the ease by which these private supplies may be made safe, it seems rather remarkable that the public has not demanded their improvement. Practically all work which has been done in determining the influence country wells have upon disease has been brought about through the energy of the state boards of health. It remains now for the individual communities to demand and to get trained whole-time health officers who upon their own initiative will purify these sources of disease.

Evidence of the need of purifying private water supplies is not wanting. The stream inspectors of the Pennsylvania Department of Health found and caused the abatement of pollutions on 17 per cent of the 418,749 properties inspected. In Ohio an examination of 489 private water supplies showed nearly one-fourth (109) to be polluted and the same proportion (106 wells) suspicious. About one-fourth of 132 well waters I examined bacteriologically in Mississippi showed the presence of colon bacilli. In Massachusetts, 16 per cent of 147 shallow wells examined by Prescott[1] gave presumptive bacteriological evidence of sewage pollution, as did 14 per cent of 42 springs. Of the deep wells of Wilmington, N. C., 24 per cent showed pollution. These results obtained in different states, and also the Minnesota work which showed that of 60 water sources used as supplies for railroads 52 per cent were declared unsafe, plainly indicate the need of extensive investigations of the small water supplies.

Wells located within built-up towns or cities may generally be accepted as being polluted even before any examination is made. Where houses closely adjoin and each has its yard privy and well, the pollution of the water is almost

[1] C. S. Prescott: *Am. Jour. Public Health*, Sept. 1913.

a surety. Such pollution will not cause typhoid fever — unless the discharges from a typhoid case or a typhoid carrier are permitted to enter the well water, — but the use of sewage-polluted water is debilitating, may cause diarrhea or chronic stomach or intestinal disorders, or may make recovery from some other diseases less certain or rapid. When private wells are allowed to exist in towns having sewerage there is more or less danger of pollution of the ground water. Unless sewer pipes are calked with great care and are so laid on solid foundation that they will not become displaced there is apt to be a certain amount of leakage from the sewer. The direction and distance this leakage may flow depends upon the soil and topography. Even when sewers are properly laid, near-by blasting or other ground concussion may dislodge the pipe, opening the joints.

WELLS

Wells are classed according to the method of their making; as, dug, driven, drilled, bored and artesian. Each kind has its own particular requirements in the making, its own particular dangers from contamination; each serves a definite purpose and each needs its own special care that its yield shall be satisfactory and pure.

Dug wells, the most shallow and open kind, vary between five and seventy-five feet in depth. They are usually between four and six feet in diameter. Driven wells are sunk through sand or other soft soil to various depths. Drilled, bored and artesian wells penetrate any kind of soil or rock, and frequently to great depths.

Pollution of dug wells usually occurs through surface washings being carried into the top by rain water or by barn or house drainage flowing over the ground surface into the well. The polluted water may percolate down the sides of the well, flowing in between the stones of the well curbing. In some cases the polluting substances seep into the soil at or some distance from the well, contaminating

the ground water before it flows into the well. The possible presence of pollution in a well water may be detected by an inspection of the surroundings, by an analysis of the water or by a study of the history of illness having occurred among those who have used the well water. More can be learned from a personal inspection than by any other method for detecting pollution, and frequently an inspection is conclusive and reveals the whole story.

In inspecting a well for pollution consideration must be given to near and distant influences: the character of the well, the condition of its opening and lining; the topography of the surrounding surface; the distances from road, barnyards, privies, pigsties, laundries, and from the kitchen, the various house drains and the milk house; the access to its vicinity given the various animals; and also to the character of the subsoil strata, the direction and angle of the dip of the strata; and the distances from water courses, swamps, lowlands and ponds, with the relative position these bodies of water or lowlands have to the possible polluting agencies. The general habits of the families living near the well are observed and the presence of any recent sickness in the immediate vicinity are noted. These constitute the principal epidemiological data observed on determining the possible influence the water supply could have had upon the health of its users, and also form the information which should accompany a specimen of water being sent to a laboratory for analysis.

A dug or shallow well is more apt to become polluted than is any other kind of well. A dug well having an old, broken platform of boards for a covering upon which people stand, and on a level with the ground may be considered as being always polluted. It receives the muddy or polluted water washing over the surface of the ground and receives innumerable masses of filth from dogs, chickens and cows and the manure dropping off the shoes of those who go to the well. The built-up, open well, without a covering, pro-

vided with a well-sweep, bucket or a windlass, is less apt to become contaminated than is the well which is level with the ground surface. Where the built-up well has sides of boards there is usually a puddle breeding mosquitoes by the side, and openings in front receiving polluting surface wash. The open top of this well is exposed to dust from the roadside or barnyard, to dirt dropping from the hands or clothes, and droppings from fowls or other birds. If the well is

MOST BARNYARD WELLS ARE POLLUTED

located in a depression, it is almost certain to receive surface wash, even though the well is bricked above the ground, the water trickling down the outside of the well and dripping in between the lower curbstones. Any well which is located in a barnyard is always contaminated, and whoever uses such well water drinks manure water in greater or less concentration. Such wells should be condemned because of their location.

Driven or drilled wells offer little opportunity of pollution

from surface washings, unless the wells are not very deep and are located in a depression or in a wet barnyard. Mason reported the condition of a well 226 feet deep, drilled through rock, which was found to receive pollution which flowed from privies through seams in the rock.

The best appliance for obtaining water from a shallow well is a cast-iron pump, when the water is to be drawn at the well. The best service is that given by an electric or gasoline pump, piping the water to the house. The other methods of drawing the water at the well in the order of their desirability and safety, next to the cast-iron pump, would be enumerated as the galvanized or hardwood bucket on a windlass operating under cover, chain buckets operating under cover, the wooden pump, the bucket on a windlass in an open well and the Colonial well-sweep; and the most unsanitary and most objectionable is the moss-covered bucket hung by a rope in the open well. The picturesque well and the old oaken bucket from which all the farm hands drink must be pronounced a menace. Driven and drilled wells are usually provided with cast-iron pumps in the North. In the South many drilled wells are equipped with long zinc or galvanized iron buckets on a rope. The pump is the more desirable, but the more costly. The spout galvanized pump, rather than the pitcher form of discharge pipe, should be selected, since it avoids collecting dust and makes drinking directly from it more difficult. The opening should be wire screened or covered with coarse cloth to prevent people thrusting dirty or contaminated fingers into the pipe.

Ground Water. — Underground contamination may occur with any kind of well, but is more apt to effect the shallow wells. With shallow wells the polluting substances may be carried from the surface but a few feet from the well directly into it. In other instances the ground water supplying the well becomes contaminated from a more or less distant point. To detect a possible pollution of the water

supply the prime consideration relates to the direction of flow of the ground water. If the ground water is known to flow in a direction from the well toward a cesspool, seepage from that cesspool could scarcely affect the well. If the direction of flow is at right angles to a line drawn between the well and cesspool a contamination from this source is not likely unless the well is rather deep, the ground level, the cesspool near or the flow of ground water sluggish. If the water is suspected of flowing from the cesspool toward the well, the cesspool and well should each be condemned until arrangements are made to prevent further pollution.

The direction of flow of ground water is judged chiefly topographically. It usually is parallel to the dip of the surface of the ground, following the course which would be taken by water upon the surface. The ground water may, however, flow in the opposite direction when the subsoil is rock. If it does not follow the surface it is more apt to flow in the opposite direction rather than at right angles to it, unless the underlying ground be of large boulders, limestone or igneous rocks, as schist, quartz or granite. If the ground slopes down from the well and encounters an outcropping of a different character of geological formation, as an exposure of stone or clay, the direction of flow of the ground water may be considered to be in the opposite direction from the slope of the ground, unless a series of exposures of the stratified stone or clay indicate a slope or dip in another direction. In such a case the ground water would flow in the direction as indicated by the surface of the impervious stratum of rock or clay. Where the subsoil is known to be loam, sand, gravel, conglomerate, disintegrated shale or other soil of uniform porosity, the direction may be considered as parallel with the slope of the surface. The direction of flow is also determined by the presence of near-by water courses. The ground water will flow toward a stream or river, toward a lake, pond or swamp

or toward a low-lying meadow or damp depression. If the well is located on level ground equidistant from two streams the ground water may be regarded as flowing toward the larger or deeper stream unless defined by other evidence. If the streams are of equal size the more rapidly flowing one may attract the water, or the ground water may flow toward their point of confluence. If there are wells located upon level ground, far from any water course, and one well was necessarily sunk deeper than another, the water surface or water-table at the deeper well was lower. The water flows, in this case, from the more shallow well in the general direction of the deeper well. If the wells in a level territory are of equal depth the ground water probably exists as a subterranean lake, of wide extent and with little or no flow. It is most difficult to prevent contamination of such wells, for seepage of any drainage may in time reach the ground water, polluting it. In such an instance it is simply a question of how long it will require the supply of pollution to reach the water supply in sufficient quantities as to become objectionable. To delay this pollution certain special activities must be undertaken, chief of which are chemical sterilization of all liquidated sewage and subsoil irrigation of all household wastes.

The experimental determination of the direction of the flow of ground water occasionally becomes necessary. Two or more, or a series, of wells may be sunk and the depth of the water-table, or surface of the ground water, measured. A comparison of these with the absolute level may indicate the direction of flow. A series of wells may be driven in a circle, and into the well in the middle of the circle is poured some chemical which is absorbed by the water and carried in the direction of the other wells. The waters of the various wells are tested frequently for the chemical and by its appearance the direction and velocity of flow is determined. The chemicals usually used for such testing are large quantities of salt, a quantity of coal oil, an intensely

colored coal-tar dye, as magenta, or an oil solution with a penetrating odor, as peppermint oil.

The rapidity of flow of ground water depends upon the relative size of voids (the spaces between the particles of sand or rock which are filled with air); upon the sizes of the particles of sand, or gravel or boulders; upon the freedom from roots or other vegetable matter; upon the compactness of the subsoil; upon the presence or absence of fissures; and upon the presence and relative proportion of large boulders contained in the gravel or loam subsoil. These characters of subsoil are of importance in considering the approximate yield of a well and in estimating the probable contamination being introduced from some distant point. They are also of importance for an allowance in the disinfection of a well. Subsoils which permit a more rapid flow of water will produce a greater water yield, the supply being continuous. It may be impossible to pump such wells dry by hand pumps. A well which can easily be pumped dry is one sunk in a subsoil permitting but a slow flowing ground water, as the total available supply is small and easily exhausted.

The more dangerous pollution of wells occurs from the contamination of the water by the body discharges of people, the most dangerous waste being the body discharges of those who have typhoid fever or are convalescing from it. Any pollution of any water supply by any human body discharges may do great damage, and should be zealously guarded against. As far as is possible and practical, no water supplies of any size should be permitted to receive untreated human wastes. Such sewage added to large rivers or lakes receives a partial purification through dilution, settling and death of the pathogenic bacteria. But such natural purification is not possible in well water. The animal discharges in the barnyards and fields which are permitted to contaminate wells may have an influence in generating tuberculosis. In many instances the use of such

barnyard water produces attacks of diarrhea or chronic gastric or intestinal disturbances. Such household wastes as kitchen and laundry drainage, through the caustic alkalies and by the decomposing vegetable matters, may induce digestive or other discomforts. All avenues of possible pollution of the well water should be carefully inspected, and active measures be taken to guard the supply.

Disinfection of Wells. — Disinfection of the well should be attempted where the well is believed to be contaminated by human wastes or where suspected of having caused disease. When a well is condemned as being dangerously polluted it is wrong to simply close the well and dig another in the same locality. By filling the well, the polluted water is forced out into the whole ground supply, and by digging another well this already polluted water is again drawn upon. If the well is known to be polluted it should be disinfected by the effective use of calcium hypochlorite, and after twenty-four hours be pumped dry and may then be filled with clean earth which has not been fertilized. A new well may then be sunk at as great a distance from the old well as possible. Disinfection followed by further use of the contaminated well is more efficacious, more important and much cheaper than is simply a closure of the old well and the digging of a new one in the still contaminated soil. When a well is to be disinfected the source of the particular pollution should be sought and the particular channel or passageway which was followed by the pollution be traced. The point of pollution and the passageway, whether a sewer pipe, a rock fissure or soil channel, a ditch or a track along the surface, are also sterilized as effectively as possible. The well is disinfected by pouring into it a solution of calcium hypochlorite, the so-called chloride of lime or bleach. This solution of calcium hypochlorite is added to the well water in the proportion of 5 parts per million, or one pound of chloride of lime to 25,000 gallons or 332.6 cubic feet of water.

TO DISINFECT A SHALLOW WELL

Take one level teaspoonful of fresh chloride of lime from a can not previously opened. Rub it up in a cup with an equal quantity of water until all lumps are broken and the whole is moistened into a paste. Dilute this with a small quantity of water. Add to a pail of water and use in the following proportions, according to the diameter of the well:

Diameter										
4 feet,	use	this	quantity	for	every	86	ft.	depth	of	water.
5 "	"	"	"	"	"	53	"	"	"	"
6 "	"	"	"	"	"	37	"	"	"	"

With a closed well remove the valve and plunger from the pump, pour in the pail of disinfecting solution and follow this with three more pails of water to wash all the solution out of the pump. After adding the chlorinated lime in the proper proportions the well should be pumped dry and allowed to refill before use, as an added precaution. Disinfection after a heavy rain is to be preferred, as the solution then has more opportunity to reach the upper level of the water-table. The disinfector must be certain to have all the chloride of lime thoroughly dissolved before adding it to the water. It may be filtered.

The practical disinfection of a well depends upon the rapidity of flow of the available supply. A shallow well known to be easily pumped dry can be efficiently disinfected. Such a well is one dug or sunk in a subsoil not permitting a rapid flow of water. The water in this well remains stationary and would tend to stagnate if not drawn upon. When such a well becomes polluted, as being infected by typhoid discharges, it can be accepted that the contamination occurred from surface washings or from near-by sources. In such a well the pollution tends to remain in the well and its disinfection is possible and practical. The

relocating of a well without the thorough disinfection of the old well and without the discovery and elimination of the source of pollution is useless. Toward a well with sluggish flow of ground water the pollution enters from all directions, since there is practically no upstream to the ground water.

Where it is known that a well cannot be pumped dry, or where the character of the subsoil, the topography or other geological formations indicate that there is a rapid flow of ground water, the attempted disinfection of the well will not give very promising results. If a well cannot readily be exhausted by hand pumping there is a rapid flow of ground water which comes in as fast as the water is pumped out. If such a well becomes polluted to such an extent as to cause damage to health, it is probable that the contamination has come from some distant source. There is more or less constant renewal of the water in the well, there is no opportunity to stagnate, and whatever flows into the well will flow out. Therefore, contamination of such a well is of short duration; if introduced from surface washings the contamination is for a very brief time unless the ground surface remains a constant source of pollution; the polluting substances after getting into the well tend to flow onward with the rapid flow of the ground water and will cause a general widespread pollution of the ground water, involving distant wells or springs which are in the direction of flow. When such a well, sunk into a stratum of rapidly flowing water, becomes contaminated, its treatment is entirely different from that given a sluggish or stagnant well. It is useless to abandon and to close the well. It is useless to try pumping it dry after using the disinfectant. The disinfectant should be used in large quantities and should be left in the well, being given the opportunity to flow onward to disinfect the ground infected by the water which has passed. The well water may be used for drinking as soon as there is no noticeable taste from the bleach.

The source from which location the pollution was admitted to the wells should be carefully located and be given its approximate treatment. Where the pollution has been washed over the surface of the ground from a near-by small area the grass should be cut, the area covered with hay or straw to a depth of six inches and burned over. Or, the area may be thoroughly wet with water containing dissolved chloride of lime (in proportions of one ounce to one barrel of water). The area may be well sprinkled with fresh chloride of lime or be whitewashed with freshly dissolved unslaked lime. The surface should not be ploughed at once. Sunlight, after the dried grass has been burnt, is an excellent disinfectant. To prevent future contamination by surface washings, the use of drains or ditches and the reconstruction of the well may suffice. Such polluting points as privies, pigpens, manure heaps and refuse piles should be relocated. With slow flowing ground water damage resulting from a well would indicate near pollution. With rapidly flowing ground water distant pollution would be indicated, especially if the evidence of damage lasts over a long time.

House Drains. — Drains should not always be accepted as tight and safe, especially after being laid for some years. They may have become jarred open by heavy wagons, be broken, or be forced open by the roots of trees. A person should not take it for granted that the drain is safe and whole, but should occasionally dig up the drain and examine it. This is especially necessary when the drains are near trees or roadways, and where laid near wells. The supposition that a long laid drain is perfect is a dangerous assumption. A hotel proprietor refused the advice of a sanitary engineer to examine a drain which extended past the hotel well. Within a short time a typhoid convalescent came to the hotel and after cases of typhoid, resulting in deaths, came from that well, the drain was dug up and found broken and discharging directly into the well. The pros-

perity of the hotel rapidly declined and the hotel was soon abandoned.

Drains which are apt to cause a contamination of a water supply should be relocated and the drain pipes be calked tight. Board troughs or ditches should not be used for drains where there is a possibility of the surface wash from them flowing into the water supply, or where a seepage into the ground may contaminate the ground water before it reaches the well. Privies and cesspools should be removed, relocated or otherwise made safe. Where wells are sunk in barnyards the water is undoubtedly contaminated, unless the barnyard is on the side of a steep hill and remains constantly dry and the soil is compact. Wells as commonly sunk in the level or moist barnyard should be condemned and filled, and a new well sunk in a safe location. If the well is situated at some distance from the barnyard a ditch between may in some cases prevent contamination of the water; it may be necessary to remove the barnyard by rearranging the fences so the cows cannot wait or collect near the barn, but remain at some distance, from which a narrow lane leads to the barn door. The barn floor and gutter are then provided with proper drainage leading safely away from the well. It may finally be necessary to relocate the well. Local masses of pollution which are found to contaminate wells after seeping into the ground water — as occurs from privy vaults, broken drains, cesspools, pig-pens draining into depressions, or places where household wastes have been thrown — should be disinfected by using large quantities of dissolved chloride of lime. The quantities used should be sufficiently large for the solution to seep into the ground and follow the channels taken by the polluting fluids, so that as much as possible of the underground distance to the well may be disinfected.

Distant pollution of wells can be suspected when the evidence shows that harmful effects from the water have extended over a long time and in the absence of distinctly

dangerous pollution from drains, privies or barnyards. Rapidly flowing ground water would tend to point toward distant pollution. The appearance in a small community, as upon a farm, of occasional cases of typhoid fever extending over a long period of time does not necessarily condemn a water supply. A typhoid carrier is almost certainly the source in such an instance.

To condemn a well on the supposition that it could be the only cause of a typhoid outbreak entails an unnecessary expense and a loss of misplaced confidence of safety. Two instances of those which I have seen will explain the fallacy of drawing conclusions too rapidly. Upon one farm six cases of typhoid fever appeared within five years. After each appearance of the second, fourth, fifth and sixth cases, the well which had been used last was condemned and a new well sunk. Five sixty-foot driven wells, upon advice of the local health officer, were sunk upon level ground and all within a radius of twenty feet, when the real cause of the cases was a typhoid carrier, a colored woman who was occasionally used as a washerwoman and rarely as a cook. Each case developed after she had cooked for the family. She had previously had typhoid fever. In the other instance a physician condemned a well, much to the detriment of the owner, when a neighbor, who was a typhoid carrier, made butter and occasionally sold it to the neighboring farmers, thereby producing seven cases of typhoid fever. In the presence of localized outbreaks of typhoid fever an epidemiologist should make an investigation to prevent needless waste of life and money.

DETECTING TYPHOID POLLUTION IN WELLS

The detection of typhoid contamination of a well rests upon the epidemiological evidence that the sequence of cases pointed toward water-carriage, and upon an inspection showing conclusively that the dejecta as discarded could have gotten into the well water. A bacteriological

examination showing the presence of colon bacilli in the water would be presumptive, but not final evidence. The complete isolation and identification of typhoid bacilli in the water would condemn the water, but would not necessarily prove that all cases came from that one source. The epidemiological evidence which would point toward the well as having been the transmitting agency of the water would include: All cases of typhoid which contracted the infection from the water would be users of the well; the time of appearance of the cases would point against personal contact, one would follow another in much less than two weeks; cases separated by the full incubation of two weeks would not have been in contact with each other; the cases would not have been exposed to any other common possible source, as milk, fly or food infection; people who were not users of the well would not be attacked except through some other channel of infection to which the others were not exposed; those who use the well constantly would become ill before those who use it only occasionally; and, finally, the outbreak would be centered around the well — it would be a sudden explosion, several cases suddenly appearing, perhaps following two or three weeks after another known single case. A majority of the susceptible people using this well might be attacked, especially if it is learned that they have poor resistance or are otherwise below a normal standard of health. Following the sudden appearance of some cases of typhoid fever in a local community the history of the community should be obtained, respecting any absentees, their time of departure and return and their place of visiting; especially should the appearance of any visitors who arrived two weeks or longer before the outbreak be learned. Each visitor is interrogated in regard to his history of typhoid, of exposures, of previous residence and the typhoid condition of that place. The time of arrival of each visitor, the personal habits, the definite location of disposal of all body discharges; the

relations the visitor has had with each person who became ill, with the kitchens, the dairies, the milkmen, the pumps and wells are all noted. The probability of the typhoid discharges getting into the water should be shown before the water supply is finally condemned. This entails a careful examination of all locations where the known typhoid discharges, both intestinal and kidney, were deposited. It should be learned if and how these discharges could be carried from the privy, cesspool or other location; and if, how and when they could have been carried into the water supply. A knowledge of how wells may become contaminated is essential, and an understanding of how to discover and what to deduct is important. This has already been outlined.

The treatment of a typhoid-infected water supply is of greater importance than the discovery. Since the proper treatment, as outlined, is safe, convenient and cheap, it may be adopted even when the well is not definitely incriminated. But if the well is not convicted, its innocence should be established, that the guilty transmitter of the infection may be apprehended. The possible typhoid contamination of a spring, a spring-house water, an underground cistern, the mouth of a faucet, a publicly used cup, or of a milk or food supply are all worked out upon similar epidemiological lines.

PROTECTING WATER SUPPLIES

The conservation of the natural condition of the water-courses is of momentous import, for the protection afforded water supplies constitutes one great method of preventing disease. It is not sufficient to detect and to treat the cases of typhoid fever, of intestinal disorders or of the numerous other diseases and conditions arising from the use of polluted waters. It is not enough to permit pollution of waters and then adopt means to attempt a purification of those supplies. Active and efficient but yet practical means should be taken

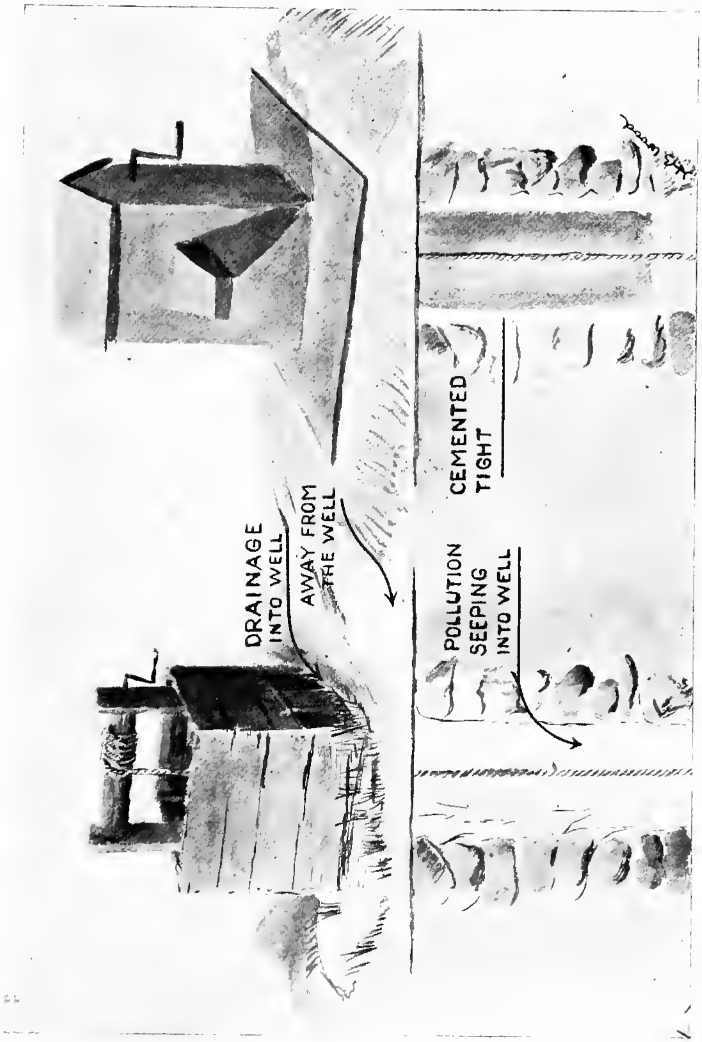
to prevent the pollution occurring. These measures should be practical from the standpoints of efficiency, of economy, of scientific design and of intelligent maintenance. Plans for protecting or those for purifying water supplies should not receive final selection and adoption unless it is believed the means will largely accomplish the desired results. Either the protection or else the purification of a water supply may be the greater economy. Protection of a watershed may reduce the work of a filter plant and decrease risks. It is cheaper and more safe and satisfactory to purify a river water supply by filtration of the water than by purifying the sewage of an upstream city; but a partial treatment of the sewage may make the water more safe and its treatment more economical for the city down the river. The designs and plans for treating the water supplies should be thoroughly considered in detail from all angles before adoption; the improvements should be made to be permanent. Plans do not perfect themselves but must be carefully campaigned, and the final improvements be conducted and maintained with intelligence and watchfulness. Not only should water supplies be made as pure as is practical and possible, but their sources should be so protected and guarded as to prevent future pollution.

Protecting Private Supplies. — Wells should be protected to prevent the admittance of polluting substances. They should be located with a view to escape contamination as much as to produce a maximum yield. The ground immediately around a well should be elevated to prevent the collection of muddy surface water which can trickle down into the well. The well cover should be built tight of cement or stone work or of a double layer of planking elevated above the surface. The well-curbing should be cemented on the inside for a distance of five or six feet down. Deep wells should be protected against surface wash and surface percolation by having all joints of casings made tight. Galvanized iron pumps with the spout form

of discharge, rather than the pitcher mouth, are the more desirable.

Springs are guarded against surface wash by being surrounded by ditches or built-up curbing. The manuring of fields on the up-hill side of springs should not be done within three hundred feet.

Cisterns. — Cisterns are used in many localities as offering the only available water supply. They are better built above ground for safety. When built below ground the water is more apt to become contaminated, but less apt to be " flat " and to freeze. Stored underground, the water is cooler in summer. When built underground, cisterns should be located up-hill and as far away as possible from all drains, toilets and barnyards. The bottom of the cistern should not be as deep in the ground as the extreme upper limit of the ground water. This will help to assure purity of the stored water. Every stone, cement or concreted cistern should be regarded as leaching to a greater or less extent. If the water in the cistern is above the ground water the leaking will be outwardly, this preventing a possible pollution of the cistern supply by the ground water. The cistern should be built as tight as possible; an effective method is the painting, with a whitewash brush, on the inside wall and bottom, of three or more coats of neat or clear cement wash, very liquid in consistency, each coat being applied before the previous one is entirely dry. This wash is made of only Portland cement and water. The proportionate strength of concrete for these cisterns and similar work may be 1 : 2 : 6 — one part cement mixed with two parts of sand and 6 parts of screened gravel or broken stone. A richer concrete — having a greater proportion of Portland cement — may be used. Coarse sand requires more cement than does fine. If bank gravel, containing a considerable proportion of sand, is used it may be used in the ratio of one part of cement to five or six of the unscreened bank gravel.



Polluted Protected

DUG WELLS SHOULD BE MADE SAFE

The sides of the cistern should be continued about two feet above the ground surface, and a tight cover maintained. Since cisterns form favorite sites for the breeding of mosquitoes, all openings at the top of all cisterns, and at the intake pipes and ventilators, should be well screened with fine, 16-mesh mosquito netting. If black or corrugated wire netting is used it should be painted when put on. Small animals, as rats, mice and muskrats, have a propensity to get into subterranean cisterns unless prevented. Cisterns supplied by roof water should be guarded against receiving leaves or sticks which collect upon the roof. The rain-leader or down-spout which carries rain from the roof should be provided with a wire guard at the top to hold back the leaves, and with a two-way valve at the bottom. At the beginning of a rain the valve is turned to discard the first water which washes from the roof dirt and pieces of leaves and sticks. After the roof gutter is washed clean, the water is collected in the cistern.

Bubbling Fountains. — Bubbling fountains are fortunately replacing many dangerous public drinking cups. They should be installed wherever public demands and public needs have provided public drinking water — in stations, railroad trains, Pullman cars, large stores, waiting rooms, lavatories, schools, courthouses, jails, at street founts, in parks and recreation centers, in permanent military camps and in religious camps, in hospitals and dispensaries and upon boats. Some of the bubblers are not entirely satisfactory since they permit drinking as though from a cup, the lips coming in contact with the brim. In the most sanitary bubbler the fountain is guarded by a ring or a cup which prevents the lips touching any part of the bubble, and in which the cup with a perforated bottom cannot be filled with water nor drunk from. Bubblers are not necessarily expensive; cheap forms may be constructed by any plumber. An inverted faucet, or an elbow attachment to an ordinary faucet or valve makes a useful bubbler.

PURIFICATION OF WATER

Purification of water becomes necessary when the only available supply is polluted and dangerous. Water supplies may be purified by a chemical disinfectant, by some physical agency as ultra-violet rays, through employing some coagulant followed by the removal of the suspended particles, by filtration through porous substances or through the natural agencies which occur during storage. The method to be selected for any special case depends upon the character and the amount of offending substances to be removed; upon the degree of purification required; upon the length of time purification is to be carried on; upon the distinct purposes for the purification and the object to be attained; upon the size of the available supply; upon the natural chemical content of the water; and upon the available financial resources. Each method used in purifying water has its own specific usage and its limitations, and according to these is the method selected or rejected when contemplating the improvement of a water supply. One method may be used in conjunction with another when their combined action or effect will more nearly accomplish the desired end.

Calcium Hypochlorite. — Chlorinated lime or bleach is used specifically to kill bacteria. When employed in the minute quantities which are used for this action, it has no other effect upon the water. Some claim has been made that water which has been treated with bleach has a deleterious action upon plant life, that it kills grass and discolorizes roses. Chlorinated lime is used for an immediate sterilization of a local water supply for temporary effect, for municipal as well as individual usage; it is occasionally added to a filtered water; and it is used for sterilizing raw or treated sewages. It is used in waters comparatively free from turbidity and organic matter, as such substances decrease its activity.

CHLORINATION

Chlorination may be used as a valuable expedient to overcome a sudden pollution of a water supply, as an adjunct to a filtration method or to be adopted until the community concerned is able to install a purification method known to be harmless or to obtain a water supply beyond the bounds of possible contamination. There seems to be no way to prove the remote risk of drinking chemically treated waters.

A chlorination system may be an emergency outfit constructed of such materials as may be on hand, or it may be of more or less permanent design.

Chlorination of a water supply, sewage effluent or other wastes is obtained through the use of calcium hypochlorite or bleach, or by the use of chlorine gas. The apparatus used in mixing calcium hypochlorite, the so-called chloride of lime, with water is termed a hypochlorite dosing device, and that for using chlorine gas, a chlorinator or chlorine control apparatus.

Chlorine is obtained by the electrolytic decomposition of salt solutions, the by-products being chlorine gas and caustic soda. Liquid chlorine is obtained by drying and compressing chlorine gas. Calcium hypochlorite is formed by passing chlorine over lime; the lime absorbs the chlorine and serves as an inert carrier of it. The bactericidal effect of chlorine is practically immediate.

Emergency Hypochlorite Plant. — An emergency calcium hypochlorite system may be installed where immediate action is needed, without waiting for the chlorine tanks and apparatus to arrive, and where the financial outlay will not permit the more substantial or reliable apparatus.

The hypochlorite system consists of the dissolving tanks, the solution tank, the dosing device and the necessary connections. The bleach is mixed with the water in the first set of tanks, is stored in solution in the second of the series and thence flows into the water supply under constant pressure, or head, which is maintained automatically.

The mixing tanks for dissolving the bleach may be constructed permanently as a pair of concrete tanks, each having a capacity of one day's supply. A minimum quantity of solution which can be properly controlled and measured is about 15 gallons per hour, or 360 gallons capacity, if the plant is to run twenty-four hours without attention, which would be a tank of inside measurements about 4 by 4 feet with 3 feet of depth to the water level.

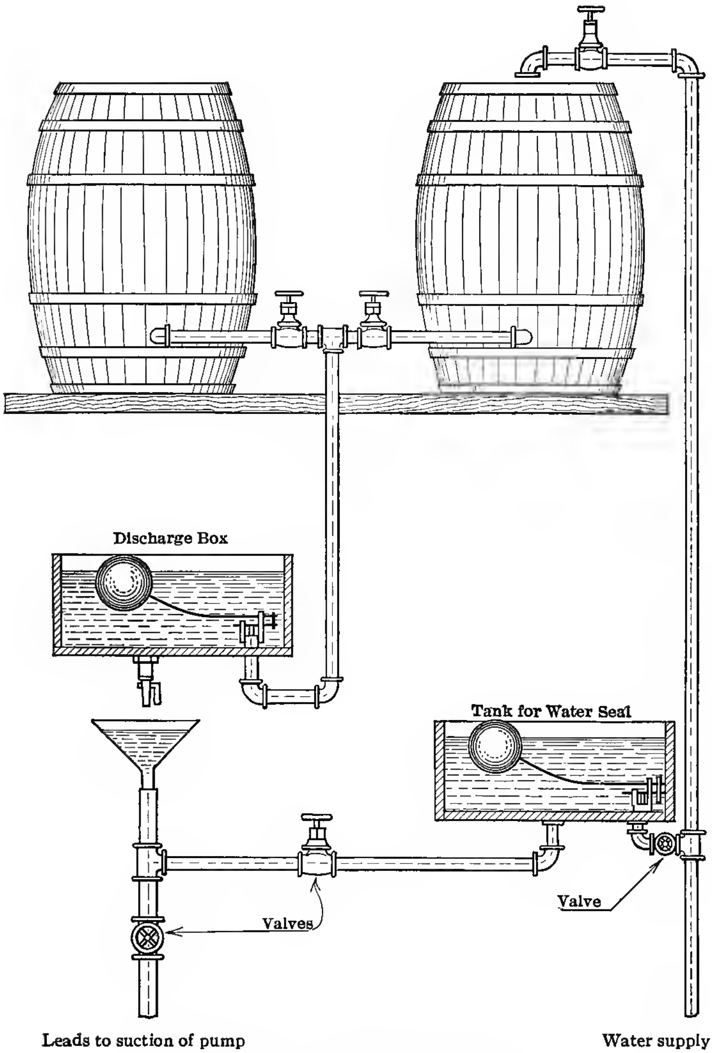
Emergency mixing and solution tanks may be built of six or seven good vinegar barrels. They should be well painted on the inside with asphaltum or some good mineral paint. Whiskey barrels make excellent solution tanks. A flaming match or burning newspaper should be dropped inside to ignite the alcohol to char the inner surface. Any of these barrels can be expected to last two years or more. The piping may be galvanized iron pipe. It will last about three months. Brass pipe is less durable, becoming rapidly clogged with green concretions. Black iron pipe is rapidly destroyed. Hard rubber connections are difficult to use. When used, the rubber may become brittle or may become spongy through the effect of the chlorine.

The capacity of the small tanks should be not less than 25 to 35 gallons; in larger installations the total capacity of the mixing tanks should allow for at least 2½ gallons per pound of bleach. Barrels average 50 gallons capacity; upon whiskey and vinegar barrels there is usually found a government seal indicating the capacity, otherwise the capacity is taken as 50 gallons; coal oil barrels hold 42 gallons; oil barrels, 50 gallons and gasoline iron drums hold 55 gallons. It is advisable to have a definite quantity of water in the mixing tank, as 40 gallons, and to add to this the quantity of bleach required for 24 hours' running. For 0.1 part available chlorine per million parts of water 2.5 pounds of hypochlorite of lime are used. This is added to the 40 gallons of water, thoroughly stirred, covered, allowed to stand 4 hours or longer, and then run into the solution

tank to be entirely used during the twenty-four hours; only the clear supernatant solution is drawn off. The insoluble sediment and scum should not get into the solution tank. The solution tank should be marked to indicate a definite capacity to which mark the dissolved bleach is diluted with water. If the water is pumped only during ten hours, the bleach solution is added during the hours of pumping and allowance in dosage is made to accommodate for hourly variations in pumping.

On the basis of 33 per cent bleach, 25 pounds per million gallons of water will give one part per million of available chlorine. Chlorinated lime usually tests between 27 and 35 per cent available chlorine. For practical purposes it may be used on the working basis of 30 per cent for emergency work. Clear, colorless ground water, free from iron, or the clear water of large lakes requires as a rule from 0.1 to 0.3 parts of chlorine, or 2.5 to 7.5 pounds of bleaching powder per million gallons. Mountain streams and upland water free from color and turbidity, and without storage in ponds, require from 0.2 to 0.5 parts of chlorine, or from $2\frac{1}{2}$ to $12\frac{1}{2}$ pounds of bleaching powder per million gallons. Waters requiring a large amount of bleach are most easily handled because the reaction is rapidly completed and the excess of disinfectant is eliminated by the organic matter. Very pure waters, from lakes and springs, require more time to complete the disinfection (having smaller dosage), and require more careful supervision to prevent overdosage (owing to smaller amounts of organic matter). Overdosage results in unpleasant tastes and odors. When the bleach is used in as great a proportion as 2.1 parts of available chlorine an objectionable taste may appear in the water.

A sediment chamber in the mixing tank is advisable. There is much insoluble material which gravitates to the bottom of the mixing tank. A blow-off or extra wooden cock at the bottom will provide means for emptying this sludge, discharging it into the sewer or otherwise disposing



EMERGENCY HYPOCHLORITE PLANT

of it. It may be removed from an empty tank by a metal scoop.

The solution or supply tank receives by gravity the dissolved bleach from the mixing tanks which are placed at a higher level, it serves as a dilution chamber and automatically supplies the dosing chamber. A constant rate of dosage is maintained by discharging through a small orifice under a constant head or stationary pressure. A leveling device is essential to maintain the water surface in the dosing tank at a constant level. For temporary or permanent use an ordinary toilet flush tank with ball-cock regulator is satisfactory.

The water seal is an absolute necessity for the satisfactory working of the hypochlorite plant if the suction of the pump is not under pressure. The water seal keeps the pipe full of water to exclude air. If this pipe which carries the hypochlorite solution to the suction main is not kept filled with water air will enter and will be carried into the pump, causing it to become air-bound. An air-bound pump, one filled with air, has no resistance to overcome and runs very rapidly, breaking valve heads and may crack the foundations. The bleach solution as it trickles down from the orifice box into the funnel does not keep the pipe filled. It is necessary, therefore, to provide for a constant flow of water in this pipe. This may be obtained by connecting with the general supply pipe, which contains water under pressure, an ordinary flush tank as made for water closets.[1] The ball cock serves to prevent too great a flow of water. The valve on the pipe leading to the main, that under the funnel, should be closed to such an extent that the discharge from the orifice box just runs down slowly; the water from the sealing tank is turned on, and maintains a constant level of the water in the funnel.

[1] A method designed by Mr. Mayo Tolman, chief engineer, West Virginia State Department of Health.

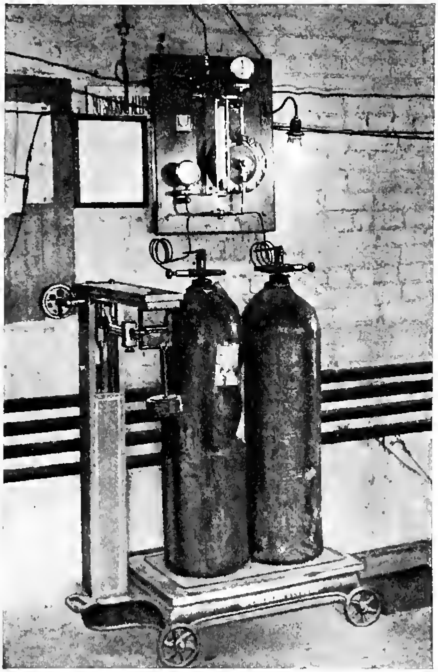
When a single plunger pump is in use a shock absorber is needed on the pipe which leads from the orifice or discharge box to the suction main. This is essential because with the single plunger pump there is a water-hammer, or backward drive of the water in the pipe, which may force the water upward out of the funnel. If a pressure tank is supplied this will receive and accommodate this backward pressure. If a half-inch pipe is used to carry the bleach water from the funnel to the suction main, an absorption chamber may be made on its course by adding a piece of one-and-a-half-inch or two-inch pipe, attached by reducing-couplers to the pipe. This arrangement is usually not necessary when triplex pumps are used.

An emergency temporary leveling regulator for maintaining a constant surface in the dosing tank may be constructed after the design by Phelps.[1] Into the bottom of a wooden tank the supply pipe projects, ending in an inverted elbow. A piece of thin rubber tubing is attached over the bottom of the elbow. The free end of tubing is tied to a piece of wood or old electric light bulb, to serve as a float. The dissolved bleach flows through the rubber tube and when enough has flowed into the tank the rising surface raises the float and kinks the rubber tube, shutting off the supply.

The bleach solution is carried from this tank by a siphon made of glass tubing, which terminates in a fine point, to drip into the funnel leading to the water supply pipe. The effective working head, or force, of this dosage tank is measured from the outside lower end of the siphon tube to the top of the water in the tank. Doubling the head or this distance over any orifice increases the flow in the ratio 1 : 1.4. To double the rate of flow the head, or vertical distance, is increased four times. Variations in the rate of flow may also be obtained by changing the size of the opening in the discharge tube.

[1] Earle B. Phelps: "Chemical Disinfection of Water," *Public Health Reports*, Oct. 9, 1914, p. 2709.

Chlorine Gas Treatment. — Chlorine is replacing calcium hypochlorite as a disinfectant for municipal water supplies. Chlorine gas is more easily applied than bleach, it does not deteriorate, its flow can easily be controlled and there is not the objectionable insoluble sediment which



CHLORINATOR AND TANKS OF CHLORINE

forms in the hypochlorite mixing tanks. Chlorine gas may not always readily be obtained.

Installing a chlorinator is easily done. The chlorine is supplied in large or small pressure tanks holding the chlorine compressed to a liquid. This tank is attached to the chlorine regulator in which the liberated chlorine turns to gas and is mixed with a small amount of water. The dosage may be determined according to the composition of the

water, as outlined in the discussion of the bleach apparatus. The flow is regulated by valves in the control apparatus, operating under a gauge. From the chlorinator the chlorine flows into the water suction pipe which leads to the pumps. If chlorination is to be used in conjunction with slow filtration, the chlorine should be applied to the water leaving the filters, flowing to the storage basins. If used supplementary to mechanical filtration, the chlorine should not be added with the other chemicals used, but should be admitted to the water just after it has left the filters.

Coagulants. — Coagulants are chemicals used to cause a physical settling and removal of bacteria, coloring matter, turbidity and suspended solids from the water. The rationale of the use of coagulants is the collection of the minute particles into large masses which can be more readily strained out by the sand.

When using coagulants some method must be adopted by which the coagulants are added to the water at uniform rates to become well distributed. The coagulant most satisfactorily employed is aluminum sulphate, with or without the addition of lime as an adjuvant. Sulphate of aluminum, $Al_2(SO_4)_3$, commonly called sulphate of alumina, — which is not alum, — when added to water containing alkaline earths, chiefly carbonates, decomposes to form white, flocculent or gelatinous aluminum hydroxide. The initial reaction occurs immediately, but the coagulation into masses is more gradual. The flocculent particles of the precipitate quite rapidly coalesce into tapioca-like masses. As these form and settle they collect various fine particles floating in the water, plant organisms, bacteria, organic matter and turbidity, carrying all down together. The water is thus clarified. If the water is acid or the precipitation is not complete, it may be necessary to add lime to assist in the coagulation. The lime should be added to the water at the same time as the sulphate of alumina, care being taken that there is no splashing caused during

the mixing. An incomplete reaction between the lime and sulphate of alumina, due to improper mixing, may cause scale to form in the water mains. To prevent this occurring, effective mixing chambers and large settling basins should be used. The amount of sulphate of alumina to employ is determined experimentally in each case. Different kinds of suspended matter require varying amounts of the coagulant. Fine clay turbidity requires more than do coarse suspended particles. The amounts usually required are between 0.5 and 5 grains per gallon.

1 grain per gallon = 142.85 pounds per million gallons.
1,000,000 gallons = 133,680.4 cubic feet.

The use of too little aluminum sulphate is shown by incomplete clarification; the presence of an excessive amount is shown chemically. Too much aluminum sulphate destroys boiler tubes and may have a deleterious effect upon health. The excess of sulphate of alumina appearing in the treated water at Wilmington, N. C., was credited with corroding lead and copper fixtures and flush tanks in the city.

Ultra-violet Rays. — Ultra-violet rays, used for their bactericidal action upon water are said to have been experimentally successful,[1] but their practicability and desirability for municipal usage have not been sufficiently tested. For sterilizing a clear water where electricity may be made very cheap, as by water power, the ultra-violet rays may be an advantage. Gærtner, however, declared [2] the system is inherently unsatisfactory, as have other investigators.

Ozone. — That ozone is of practical value for sterilizing water has not been proved. The presence of turbidity and much organic matter markedly interferes with the action of ozone. Owing to the contradictory experimental evi-

[1] "Illinois State Water Survey:" *Am. Jour. Public Health*, Aug. 1914.

[2] *Trans. Fifteenth International Congress on Hygiene, Vol. IV*, 1912.

dence and to the very high cost of application the employment of ozone does not seem desirable.

Storage. — Storage of water causes a natural purification to occur if the time of storage is sufficiently long. The purification occurs to a greater or less degree in lakes and ponds and may be obtained by artificial reservoirs. The actions which the storage obtains comprise settling, dilution and destruction. Mud, dirt, bacteria and organic matter in suspension in the water will settle with various rapidities depending upon the time of quiescence and upon the lack of agitation from winds or current. The subsidence is greater during the winter, hence the water flowing from the storage reservoir will have a higher degree of purity during the cold months. Dilution of concentrated quantities of contaminating substances occurs in large bodies of water, depending for their rapidity of dispersion upon the amount of agitation the water receives. This dispersion of a small quantity of pollution throughout a large body of water is termed equalization by Houston. This dilution and distribution of pollution decreases its toxicity. By dilution and storage pathogenic micro-organisms become separated from their food supplies and rapidly lose their virulence or become destroyed. The devitalization of the bacteria is the greatest result which storage achieves for the public health. The ultimate natural fate of typhoid bacilli is simply a question of time. Whether they die in a storage reservoir or within the interstices of a sand filter matters little. The availability of sufficient storage or of a satisfactory filter is the question to consider. In natural or in polluted waters typhoid bacilli decrease rapidly after a few days and almost have disappeared at the end of a week. Thirty days storage would perhaps entirely eliminate them. Houston has shown[1] that 770,000 typhoid bacilli in Thames River water reduced to 4 in one week, and on the fourteenth

[1] A. C. Houston: *Trans. Fifteenth International Congress on Hygiene, Vol. VI*, 1912.

day none could be isolated. Also, of 1650 per c.c. none could be found in one cubic centimeter after a week.

The practical advantages of water storage are that subsidence of suspended particles and the disappearance of organisms will produce a greater purity of the water, whether that water is subsequently filtered or not; and by providing a clearer, purer water for filtration the filter-beds may be much smaller and be worked more economically. The storage reservoir also provides a large supply of water to be drawn upon at times of drought or fire, when the available river supply or the capacity of the filters may not meet the demand, and prevents overtaxing the filters by an excessive increase in turbidity or pollution after storms. It is advisable to impound a large amount of water in large reservoirs where the watershed is not defiled, as Providence, R. I., is building, rather than to build large filtration plants for purifying excessively polluted rivers. Those improvements entailing prohibitive expense are, of course, not considered.

Sedimentation Basins. — Sedimentation basin or settling tank is the name applied to a reservoir designed for the purpose of clarification by gravity. A storage reservoir is one designed only for the purpose of retaining a large amount of water, without any specific intention of obtaining a purification. Storage reservoirs used in conjunction with slow sand filtration usually are for retaining filtered water, but sedimentation basins receive the raw, untreated water. Sedimentation basins are used where there is so much sediment in the water as to cause a rapid clogging of the filter-bed, preventing filtration and entailing great expense for frequent cleaning. By their use a more complete purification is obtainable; they also permit a larger yield per acre of the filter area. They are also used in conjunction with coagulants. The necessary capacity of settling basins depends upon the amount of insoluble particles in suspension in the water and the rapidity with which these settle. A

complete clarification is not attempted, but the basins are constructed for a reasonable removal of about 90 per cent of the suspended matter, if it can be done cheaply. If such high removal is found upon experimentation to be too expensive only half the suspended particles may be removed by sedimentation, the rest being removed on the filter-bed. Sedimentation basins designed to hold a twenty-four hour supply may be most satisfactory. Most of the suspended matter will settle by that time, and an increase of the size of the basin would permit the growth of objectionable algæ. The acreage of the basin also largely depends upon the size of the available supply, the rate of usage, and the duplication of basins for cleaning. They should be built in pairs to provide for cleaning.

The depth of water in settling basins averages about ten feet, but varies widely under different conditions. Where a coagulant is used for removing coloring matters or turbidity, the water is retained in basins before going over the filters sufficiently long to permit a settling and removal of the coagulant. Sedimentation basins need not necessarily be covered; storage reservoirs for filtered water are advisedly covered to prevent algoid growth and to preserve purity.

Water Filtration. — There is need of the filtration of water where the available public supply is unmistakably polluted by sewage to such an extent that the water becomes a constant or intermittent menace to the lives of the public; when the polluted supply is inevitably the source which must be used; when the purified supply will be safer than another source which will remain pure but a short time; and when careful epidemiological and laboratory investigations demonstrate a high typhoid rate due to the water. It is much cheaper and safer to filter water than to attempt to treat the sewage of an upstream town to such a high degree of purification as to make the water thereby drinkable. Filtered water with a removal of 99.9 per cent

of the bacteria is of a much higher degree of purity than is sewage with the same percentage of the bacteria removed. It is the bacteria which remain, rather than the percentage which has been removed, which constitute the important consideration of the potability of a filtered water. A high percentage of removal of bacteria, as 99.9 per cent, will indicate efficiency in filtration, but may not indicate a high degree of purity in the water.

Natural River Filters. — River beds of clean fine sand, which are stable, undergoing little or no scouring, in some instances make excellent natural filters. The adoption of such filters is comparatively inexpensive, since the installation consists principally in laying rows of perforated brass, strainer pipe in trenches in the river sand at depths of four or five feet beneath the sand surface, in addition to the building of pumping plants and storage basins. A natural filter of this construction is in operation at Parkersburg, W. Va., filtering Ohio River water with success, chemically and bacteriologically. The acreage is designed to produce a yield of 3 or 4,000,000 gallons per day per acre. Waters of high color, of fine turbidity, much acidity or containing much organic matter are not adapted to filtration through natural river-bed filters.

Artificial Filters. — Artificial filters are constructed according to two principles of operation: a natural adhesion or a forced straining. These two theories of water filtration are met by the use of the English or slow sand filter, and the American or rapid mechanical filter. The purification of water is accomplished by permitting the water to flow through a layer of sand, with or without the use of coagulants to assist in the straining and to permit an increase in the rate of flow.

SLOW SAND FILTERS

Slow sand filters are human adaptations of river-bed conditions, in which the water is allowed to percolate slowly

through layers of sand under a low head (water pressure or weight, or depth of water). The slow velocity of the water permits the bacteria and suspended particles of matter to adhere to the grains of sand. The dissolved inorganic salts and much of the coloring matter pass through the filter.

SLOW SAND FILTRATION VS. MECHANICAL FILTRATION

A natural percolating method.	An artificial straining.
Used for much pollution of water.	Used for slightly polluted water.
Used for waters comparatively clear of sediment and vegetable colors.	Used with colored and turbid waters.
Slow in action.	Water flows through rapidly.
Rate 4 to 5,000,000 gallons per acre per day.	Rate 100 to 150 million gallons per acre per day.
More uniform in action.	Efficiency low after cleaning.
More durable.	Appliances deteriorate.
Removes 99 per cent bacteria.	May remove 95 to 99 per cent.
The water is purer and safer.	Hygienic safety less.
Does not get seeded.	Bed may become seeded.
Removes one-third of coloring matter.	Removes nearly all dissolved color.
Coagulant necessary only to remove all color and turbidity.	Coagulant always used.
All turbidity removed only by coagulant.	Removes all turbidity.
Sand remains settled.	Bed may get soft and fluffy.
Only slightly subject to cracks.	Sand fissures more apt to occur.
Animals may burrow through.	Protected from animals.
Cleaned by scraping off surface.	Cleaned by flow of water or compressed air in reverse direction.
Sand in large beds.	Filter a small tank of wood, iron or concrete.
Much land required.	Plant has small acreage.
Cost of installation large.	First cost comparatively small.
Maintenance expense low.	Expensive to conduct.

The choice of the kind of filter to use lies chiefly upon two factors: the amount of land available and the character of the raw water. Succinctly stated, it may be ventured that the choice lies with the slow sand method of filtration, and that the mechanical filters are installed where

sufficient land cannot be obtained and where the high turbidity or high vegetable color requires a coagulant for its removal. Not all hydraulic engineers are guided by this rule, but it is the practice of many.

Efficiency. — Slow sand filters should remove over 99 per cent of the bacteria, and over 60 per cent of suspended matter. When first put into operation they remove 50 per cent of the color, but this removal soon decreases to 25 per cent. The Providence, R. I., filters, designed by S. M. Gray, C. E., remove from a highly polluted water 78.9 per cent of suspended matter (1907–1912 average), and 36.3 per cent of color (1910–1912).

Fine silt or turbidity from clay, shale or culm cannot be completely removed by a slow sand filter without the use of a coagulant.

Water is most clear during the winter, especially when the ground is snow covered. It contains the most sediment, suspended particles and bacteria in the spring and after rains and floods. These sudden strains, or relaxations, upon the capacity and efficiency of the filters should be anticipated and met by timely and appropriate action. Clear lake and reservoir water permit the use of finer sand. The use of filtered water from lakes or large reservoirs will give a lower bacterial count, and no cases of typhoid would come from such water filtered through fine sand. A heavily polluted river water containing much turbidity or suspended matter requires coarse sand, which is more porous, and a complete purification cannot be expected. A lowered filtration efficiency means some few otherwise unavoidable cases of water-borne typhoid. Municipalities should therefore seriously consider water storage in place of plain filtration, or as an adjunct to it.

The action of a sand filter-bed is a combination of various natural forces. There is more than a straining action. A clogged filter, or one which has been used a long time, is much more effective than a newly cleaned bed. The pores

upon the surface are much smaller and retain more of the suspended particles. There is a strong factor of physical filtration. Small particles of matter exert a marked attraction for each other when not affected by such forces as jolting. As the water slowly trickles down between the grains of sand the little eddies formed give the small organisms, both plant and animal, an opportunity to become attracted to the sand grains. The albuminous particles, the plant and animal organisms, become attached to the sand, by the natural force of adhesion. Those bacteria which are not surrounded by a media satisfactory for their growth, soon die. These include the typhoid organisms. Other bacteria which are offered an excellent chance to thrive are the nitrifying organisms. By their growth these bacteria decompose the organic matter present and therefore alter the chemical composition of the water. They also affect dissolved nitrogenous salts.

Operation. — The bed receives water from the river or sedimentation basins. The water flows slowly over the sand to prevent any rupture or fissuring of the surface, covering it to a depth of four or five feet. The depth of water on the sand bed, or the head of water, depends upon the desired flow, upon the size of the sand and upon the length of time since the bed was cleaned. The flow of water is regulated by increasing or decreasing the head or height of water and by influencing the loss of head (the difference in the levels between the effluent and the applied water). Coarse sand, being more porous than fine, requires less depth of water. After a filter is used for awhile the interstices in the surface layer become filled and a greater head of water is required to maintain the same flow. Water containing much sediment also requires a more rapidly increasing head to maintain a uniform flow from the filter.

The rate of filtration accomplished by slow sand filters is usually 4,000,000 to 5,000,000 gallons per acre per day.

1,000,000 gallons per acre = water 3.05 feet in depth.

When a sand filter-bed becomes so clogged that sufficient water is not flowing it must be cleaned. The imperviousness being due to the vegetable growth upon the surface, the latter, called the schmutzdecke, is removed. The growth in the raw water and in the filter-bed is much more rapid in summer than in winter. This necessitates more frequent cleaning, the intervals usually being three or four weeks in the summer, and one or two months during the winter. When the sand filter-bed is cleaned the water is lowered sufficiently and the schmutzdecke is removed. The schmutzdecke is the compact gelatinous surface which can be rolled up for removal. From one-half to three-fourths of an inch is the amount usually removed at each cleaning. This compact layer contains nearly the entire mass of bacterial plant life and suspended insoluble particles removed from the water. It formed the effective part of the filter, although the adjoining several inches have become partially involved and assist in the purification. The removal of the top surface is repeated until the thickness of the original four or five feet of sand is decreased to about two and a half feet. It is not safe to decrease the depth of the layer of sand much below two and a half feet. After this thickness is reached the sand which has been removed is washed and replaced.

After replacement of the washed sand there is a marked reduction in the efficiency of the filter owing to the increased porosity. At the filter plant at Pettaconsett, R. I., this irregularity is largely overcome by the use of "stained" sand. Below the schmutzdecke in the filter-bed the sand particles become partially coated with the materials filtered from the water. This discolored or "stained" sand is about one-fourth as porous as the washed sand, and is about four inches in depth. After the last scraping of the bed before the replacement of the washed sand, a few inches of the stained sand is removed and used as a coating of three or four inches' depth over the replaced washed sand. Such

usage makes the filter more regular, and a satisfactory action is more rapidly attained. Care must be taken that nothing injures or ruptures the surface of the sand bed, else a large quantity of the raw water will bore a hole and, rushing through, will contaminate the city supply before the hole may be naturally repaired by freshly formed schmutzdecke. A clogging of the sand bed may be caused by crenothrix, a brick-red alga. This plant may be killed by chloride of lime in solution.

Construction. — The construction of modern slow sand filters is of concrete. One acre of sand surface is usually designed to filter 3,000,000 or 4,000,000 gallons of water daily. The American city per capita consumption of water varies between 50 and 300 gallons per day. The filter-beds are usually built covered in the localities where natural ice freezes to any considerable thickness. A thick layer of ice over a sand filter-bed interrupts the action of the filter, and the frequent necessary removal of ice becomes expensive. Broken pieces of ice may injure the schmutzdecke. The most satisfactory roofing is of concrete supported upon pillars of concrete or brick. The covers have little effect upon changing the temperature of the water from that of the original supply. The inside walls of the filter are built in steps in place of having vertical smooth sides. The sharp angular steps tend to prevent any trickling or washing of the unfiltered water down the sides of the filter.

The sand layer of the filter-bed is laid to a maximum depth of four or five feet, to be scraped in cleaning down to a thickness of two and a half or three feet. Angular, clean river or bank sand is to be preferred, but either may require washing and screening to obtain a proper coefficient. Beneath the sand is a supporting stratum of graded and screened layers of gravel to a total depth of about a foot. Beneath the gravel are the underdrains for collecting the filtered water. Upon the underdrains is laid a layer of

small broken stone or very coarse, screened gravel. Above this gravel are laid the successive layers of screened gravel, the finest being on top to support the sand. The best underdrains consist of semicylindrical, concrete troughs covered with perforated, flat tiles which may be removed for cleaning.

Effective Size of Sand. — The size of the particles of sand determine its porosity, and the porosity is the controlling factor in filtration. The standards by which sand is graded are the effective size and the uniformity coefficient. Sands are measured by passing through fine wire sieves of known and graded mesh, and by determining the weighed percentages which will pass through each sieve. That size of sieve mesh which will pass only ten per cent by weight is termed the effective size of that sample of sand. A grade of sand having an effective size of 0.20 is so fine that ten per cent by weight will pass through a sieve whose meshes are 0.20 millimeter in diameter. The most satisfactory and most used effective sizes for filtration sand are between 0.20 and 0.35. Filters of very fine sands, having effective sizes 0.09 to 0.14 mm., retain all but an insignificant number of bacteria, but are rapidly clogged and require frequent and expensive cleaning. Coarser sands are more porous, require more time to become bacteriologically efficient, but are the more desirable, especially with waters containing some suspended matter.

The experiments at Lawrence[1] showed that the removal of bacteria was affected by the effective size of the sand as follows:

Effective	size	0.38	mm. removed	99.84	per	cent	bacteria.
"	"	0.29	" "	99.84	"	"	"
"	"	0.26	" "	99.90	"	"	"
"	"	0.20	" "	99.99	"	"	"
"	"	0.14	" "	99.97	"	"	"

[1] *Mass. State Board of Health Report*, 1893.

Uniformity Coefficient. — The uniformity coefficient is the ratio between the size of the sieve mesh which passes 60 per cent and the size through which only 10 per cent of the sand will pass. The closer this approaches unity the more uniform and desirable will be the sand. A coefficient of 4, or $\frac{80}{20}$, means that while ten per cent by weight will pass through the 0.20 mm. sieve, a much larger sieve is required to pass sixty per cent of the sand, 0.80 mm. mesh. A uniformity coefficient of 1.5 or $\frac{30}{20}$ indicates sand particles of much more uniform dimensions and hence more uniform porosity.

Operation of Filter. — Intermittent filtration constitutes a variation occasionally adopted for the operation of slow sand filters. With this method the water is alternately drained from the sand bed to admit air into the sand for ventilation, and the bed again flooded. In continuous filtration the flow of water upon the bed is not interrupted until cleaning becomes necessary. Intermittent filtration may be used for excessively polluted waters, those containing large quantities of decomposable organic matter and micro-organisms. Low rates of filtration are then used. For the removal of mud and moderate organic pollution continuous filtration with higher rates is preferable. The bacterial efficiency of intermittent filtration is much lower than that of continuous filtration, as the beds are more porous, have less schmutzdecke and the application of the water causes more disturbances and channels. The Massachusetts researches demonstrated that continuous filtration is quite as efficient as is intermittent. Intermittent filtration is of value with colored waters containing much iron, the latter oxidizing and removing the coloring matter.

MECHANICAL FILTERS

The rapid, American or mechanical filtration system consists of a small bed of sand enclosed in a wooden, iron or concrete container, through which water is forced at a high

rate, and provided with special appliances for washing the sand within its box. There are several types of filters, all protected by patents, and differing in the details of the shape and size of the various compartments, in different ways of stirring and washing the sand, and in the ways of applying the water and the coagulants. Owing to the patents of the better appliances and mechanical contrivances of these filters being held by different companies, the most desirable combination for a mechanical filter cannot be constructed.

Coagulants are always required with mechanical filters. Sulphate of aluminum is used in the approximate amounts between ½ and 3 grains per gallon, depending upon the amount of suspended matter. The water carbonates decompose the coagulant into a whitish, translucent, pasty jelly. The water after receiving the proper amount of coagulant is forced by pressure through a three or four foot layer of fine sand which retains the large masses collected by the coagulant. When properly managed none of the sulphate of alumina should remain in the filtered water.

The efficiency of a mechanical filter depends upon the kind and amount of coagulant used and its method of application. The arrangement of the patented appliances are directed toward convenience and economy of operation and of washing. The bacterial efficiency of mechanical filters investigated[1] at Louisville gave averages of 43 and 61 per cent. It was proved that it is economy to have long periods for storage in reservoirs when using mechanical filters. With sufficient coagulant the removal of turbidity and mud is complete. The best obtainable bacterial efficiency was 98 per cent. Mechanical filters should remove between 60 and 70 per cent of organic matter.

The rate of operating mechanical filters is high. They may filter at the rate of 2 gallons per square foot per minute, equaling 105,000,000 gallons per acre per day, up to 3 gal-

[1] George W. Fuller: "Water Purification at Louisville, Ky," 1898.

lons per square foot, or 156,000,000 gallons per acre daily. When the affluent is properly coagulated the filters may perform up to 3 gallons filtration per square foot per minute.

The cleaning of mechanical filters is done by forcing a stream of water or compressed air through the sand in a reverse direction. This is done once or twice daily. When the filtered water is used for washing it requires approximately 5 per cent of the filtered water. A velocity equivalent to a vertical rise of fifteen to eighteen inches per minute is required for washing these filters where no other means of agitation is employed, and twelve to fifteen inches per minute when a method of agitation is used. Sufficient water is essential and drains large enough to carry off this water are necessary. These wash troughs should not be so widely spaced as to permit the mud settling back upon the sand. The wash water is discarded by emptying into the passing stream. In a recent alteration in mechanical filters, the sand continuously circulates from the sand layer out into the compartments to be washed and returned immediately.

Poor washing is indicated by characteristic mud balls, cracks in the sand, patches of dirt on the bed after washing and a considerable layer of dirt over the entire bed after washing. These conditions are noted by the attendant and the cause remedied, if possible.[1]

Water Mains. — The correct laying and safe location of water mains becomes a public health problem, of which the health officer should take cognizance. Drains should be laid in trenches alone, as far from sewers and gas mains as possible. The prevention of loss of water through leaks is a consideration of economy. Mains containing water which is being distributed by gravity or by pumps are under pressure, and all leaking would be outwardly, but the collecting mains which carry water from the intake to the pumps are under the reverse pressure and the direction of

[1] *Annual Rep. N. J. State Board of Health*, 1914, p. 195.

leak would be into the main to a greater extent. These collecting mains should not be laid where they may collect any polluted water; they should be perfectly tight at the calks; they should be laid above the water table, and not through swamps or other streams unless absolutely tight. They should not be laid loose on a river or lake bed as wave motion would be apt to spring the joints and admit contaminated water. These accidents have happened and typhoid outbreaks resulted. The distributing mains should not be laid within sewers, nor within the same trench with sewers.

I believe there is a negative pressure exerted at certain times, as when a near fire hydrant is turned on or off. This negative pressure theoretically corresponds to the negative of the water-hammer and would give an opportunity for water outside the main to leak in through open joints. I believe there are known instances where this has occurred, and where a contamination of the water resulted, as with the typhoid outbreaks at Baraboo, Wis., and Palmerton, Pa. The theory of negative pressure needs proof obtained experimentally by a minute pitot tube opening from the periphery of a water main.

The water intakes should be located and arranged so that sewage, sand, mud or surface flotsam cannot be drawn into the vortex or into the pipe. They should be located where beating waves and drifting currents cannot stir up the sand or mud.

HOUSE FILTERS

House filters of small pattern usually depend upon charcoal or a porous stone composition for any virtues they are alleged to possess. In them people frequently place a confidence which is unwarranted, as their value is strictly limited. They may be used for removing some silt or the coarse sediment, yielding a water more clear and sparkling, therefore more tempting. The stone filters are most effective for removing coarse turbidity when most clogged.

When becoming impervious they are best cleaned by brushing with a stiff brush, followed by immersion in boiling water. They should not be scrubbed with sand-soap. These fine grain, sandstone house filters are absolutely unreliable for removing bacteria from water. Bacteriological researches by the writer showed them to be most effective when so nearly clogged that water would only pass through by drops, but then at least one-tenth of the bacteria in the water passed through the filter. After cleaning, the bacterial count was many times higher than that in the raw water, since cleaning increased the porosity and all the bacteria which had been detained passed through. The freshly cleaned stone filter removes only a small amount of the sediment and none of the bacteria from the water. House charcoal filters are also undependable. They retain some of the bacteria, which will rapidly increase in the filter. The filter soon becomes "seeded" and useless. Mason has shown that at the end of a month the water flowing from the six inches of charcoal will contain five times as many bacteria as the raw water. The charcoal filters should be boiled every week, and even with that precaution no dependence should be placed in them for the removal of harmful bacteria from the water. Where there is danger of contracting typhoid fever from the water, dependence should be placed in anti-typhoid vaccination, not in any kind of a small household filter.

THE VALUE OF WATER ANALYSIS

Analysis of water supplies is made to determine their potability and to discover the presence of any substances that may prove harmful in the industries. The potability of a water has reference to the desirability and safety of the water when used for drinking, to the presence of disease producing organisms, or chemical compounds, and to the esthetic conditions of color, taste and odor.

The analysis may be bacteriological, chemical or merely

physical. From the standpoint of health and the prevention of disease the bacteriological examination is of much greater importance than a chemical analysis, although in many instances neither is necessary after a careful inspection of the source of the water supply has been made.

Bacteriological Examinations. — Bacteriological examinations of water are usually made to detect the presence of colon bacilli and to estimate the numerical count of all bacteria found in the water. The finding of B. coli, whose identification is comparatively easy, is accepted as an indication of the probable pollution by sewage.

The results of such examinations are commonly accepted as probably indicating the absence or presence of pollution by sewage. If pollution is indicated, and it is shown that this water has received human sewage or the suspicions of such reception are sufficiently great, it is safe to pronounce the water dangerous to use and that it may produce typhoid fever, diarrhea or other intestinal disorders. The actual demonstration of the presence of typhoid bacilli in a water supply would be proof of the water being a transmitting agency. The attempt to detect typhoid bacilli in water is rarely made, owing to the great difficulty of isolating and identifying the typhoid bacillus, made difficult by the scarcity of organisms in the small amount of water examined, and obscured by the close resemblances of the various members of the typhoid-colon group of bacteria. The search for typhoid bacilli is deemed impractical and unnecessary. The uncertainty of finding Bacillus typhosus is further augmented by the fact that most typhoid infections of water supplies are evanescent and transient. The cases of disease, whose presence develop the suspicion of water pollution, do not begin to appear until two weeks after the infection of the water occurred, when all infected water has probably passed beyond collection by that time, and in such water the few remaining typhoid bacilli have died a natural death. In a few instances, however, typhoid

bacilli have been isolated from water which has been receiving infected sewage continuously. The paratyphoid bacillus was isolated from the Potomac River. Other pathogenic bacteria which have been isolated from water supplies include tubercle bacilli obtained from Schuylkill River water by Fox, and anthrax bacilli isolated by Rivas from a stream suspected of transmitting anthrax.

B. Coli. — The finding of colon bacilli in water is not a proof of pollution by typhoid discharge, and not even of the presence of human sewage. B. coli is an indicator, whose presence proclaims that something is wrong and needs investigating. The ordinary laboratory test does not differentiate or detect the source of the colon bacilli. These organisms are found in the intestinal discharges of all adult animals, as far as has been determined. When reported as being present in an examined water, all sources of possible pollution of that water should be investigated. Animal manure should be accepted as the source of the reported colon bacilli under the following conditions: In a well located within or down hill from a barnyard or pigpen, or located in a slight depression receiving surface drainage, or constructed so that dirt may fall from the feet of men or animals into the well; in a stream flowing through fields or woodlands frequented by animals, or flowing through fields which have been fertilized within the same year; in a spring or well located in a field and receiving surface wash. A large river flowing by cultivated fields would probably offer sufficient dilution to render difficult the finding of any colon bacilli which may have come from the fields.

The presumptive test for colon bacilli gives little information of value and should be supplanted by plate isolation of the organisms. It does not prove sewage pollution or the presence of colon bacilli, but is simply suggestive.

A bacterial standard of excellence or safety for a drinking water is desirable for some purposes, but for practical pur-

poses must be elastic to meet the varying conditions accepted as safe. A pure water would contain no bacteria, or only those which can be nothing but harmless. Waters for practical usage may be classed as safe — free from disease germs, rather than pure — safe from all germs. It is scarcely practical to set the same standard for river water which would be required for that from deep wells. Deep well water should be required to be free from colon bacilli. Such a standard set for rivers would condemn practically every surface stream. McLaughlin's tentative standard of 2 B. coli per 100 c.c. would probably be a good standard for large rivers in populous districts, although a condemning standard for many, but should not be adopted for mountainous streams or for wells.

The International Joint Commission, appointed to consider the pollution of the waters between Canada and the United States decided, in 1914, that the standard of purity for water applied to filters should not contain over 500 B. coli in the 100 c.c. presumptive test, as a yearly average, meaning that colon bacilli should not be found more than in 50 per cent of the $\frac{1}{10}$ c.c. samples. In averages for shorter times, as weeks or months, a greater B. coli content is allowable.

Ten cubic centimeters should be the maximum amount of water examined in routine work. For laboratory work in deducing decisions and for statistical reports where a standard is necessary, the absence of colon bacilli in 10 c.c. of water from deep or shallow wells, from streams in wooded or unpopulated regions and from cisterns, is suggested as a border line between acceptable and suspicious or dangerous waters. A similar standard to apply to springs, streams through cultivated fields and rivers in heavily populated regions may allow not over one or perhaps two colon bacilli to ten cubic centimeters of the water. In any of these cases, however, the standard simply indicates that those waters falling below the dividing line need further investi-

gation, especially locally, with the purpose of explaining the finding. Reexaminations are required. A water once passing the test does not necessarily obtain a permanent clean bill of health. Should the data account sent with the water to the laboratory indicate anything suspicious more examinations are advisable. A well may be in danger of pollution when the water appears safe. Whatever the results of the examination, the well needs attention. The same application may be made toward streams.

A general bacterial count of a water may give important testimony, or it may be misleading if sufficient explanatory data do not accompany the specimen when sent to the laboratory. Without much information of the conditions existing around the water supply and of the character of the supply, and unless the specimen is properly collected, the examination may be useless. A bacterial count may be so low as to command undue confidence in a supposed safe water, or so high as to produce unnecessary alarm. A bacterial count of 5000 germs to the cubic centimeter is not alone proof of pollution; neither does a count of 50 declare purity. A well, ordinarily pure, may receive some typhoid discharges, the high dilution by the well water giving a low bacterial count. Another well strictly free from all dangerous pollution may show a high count of harmless soil bacteria. A few drops of milk falling into a well will give a high bacterial count. A new well sunk by blasting or by drilling will show a very high bacterial count coming from the dynamite or from some of the tallow used to grease the drilling tools. Such factors which influence the bacterial counts should be considered when submitting water samples for bacteriological examination.

The significance of the finding of colon bacilli in water has its limitations which should be appreciated. A small quantity of sewage or a small particle of animal manure dropped into the water just before the sampling will have a marked effect, depending whether or not that immediate

pollution happens to be collected in the water sent for examination.

Collecting Samples. — The sample collected should be a true specimen representing actual conditions. The water should not be so agitated, however, that the bottom sediment is stirred up. Water samples should not be collected from a stream or spring receiving surface wash from recently manured fields, nor from streams into which farm animals walk. When collecting from pumps, pipes or faucets care should be exercised that the point of collection had not been contaminated. The writer found many colon bacilli in a water coming from a six-hundred-foot well of pure water, the collector having failed to sterilize the end of the pipe from which the water was collected and into which some one had thrust his dirty fingers. Pipes and faucets from which water specimens are collected should be sterilized by the flame of a torch or alcohol lamp, but not by the use of antiseptics. Burning paper or matches will suffice. When collecting water for bacteriological examinations at least four ounces should be obtained in a new bottle which, with its stopper, has just been boiled. Rubber stoppers are preferable to cork. Before sterilizing the bottles and collecting the samples, the hands of the collector should be thoroughly scrubbed, using soap. Care must be taken in pouring the boiled water from the bottle not to get the fingers into the water. Great care must be taken not to put the fingers into the neck of the sterilized bottle, nor to touch the small end of the stopper which goes into the bottle. The hands should not touch the water from which the sample is being collected. If collecting from a faucet, valve, pipe or pump the mouth of this delivery tube should be sterilized on the inside by a flame. When collecting from a stream or pond the bottle should be lowered beneath the surface by a string tied to the neck. A stone or other weight may be attached to make the bottle sink. The hand of the collector should not be immersed in the

water. The specimen of water should be kept upon ice and shipped immediately to the laboratory. A few hours in the sunshine or a few days of delay will materially alter the composition of a water, producing misleading results.

Data. — Complete information should accompany all specimens sent to the laboratory, as follows:

DATA BLANK FOR PUBLIC WATER SUPPLIES

River water:

Name and location of stream, width, depth, approximate rate of flow.
Name of towns up stream and distances above sampling point.
Character of country; populated, wooded, mountainous, swampy, cultivated fields, hilly or level contour.
Character and distances of known polluting points.

Lake or pond water:

Location, length, breadth and depth of lake or pond.
Distances from inflowing streams and from towns.
Character of surroundings; wooded, swampy or cultivated fields.
Distance from shore and depth below surface of taking example.

The specific reasons for making the examination and the kind of examination desired should be stated. It is as much from the accompanying data as from the examination itself, that the analyst is able to judge of the potability of a water and of the necessity of other tests. For a data blank to represent private water supplies the following is recommended:

PRIVATE WATER SUPPLY DATA

Name tenant. Address. County.
No. persons in household. Occupation of tenant.
No. of day-laborers. Servants.
Recent diseases in family? When was typhoid present?
Source of water supply; well, cistern, spring, stream.
Depth of well. Kind of subsoil.
Kind of well; dug, driven, bored, deep. Use pump, windlass, bucket?
Distances in feet from kitchen, drain, cesspool, privy, barnyard, garden.
From which of these is well or spring down hill? Distance in feet.
Does surface wash flow toward well? Condition of well platform.
When water supply last cleaned? How cleaned?
Is water piped to house?
Tank used? Concrete, wood or iron? Located in house, cellar, outdoors, barn, under ground?

On back of report make a drawing showing the location of all buildings, privies, fields, barns and other polluting factors, giving distances and the direction of the slope of the land.

CHEMICAL ANALYSIS

A chemical analysis of a water supply may detect sewage pollution, contamination by organic substances, differentiating between recent and remote contamination. It may detect the presence of chemical or trade wastes and determine the effect produced by certain geological, biological and meteorological influences. It can determine if a certain pollution by sewage has been recent or if it was received at a period remote in time or distance, but cannot determine if that pollution will produce disease. On account of this limitation, chemical analysis of water supplies is of much less value and importance in the prevention of sickness and the saving of lives than is the less expensive and less tedious examination for bacteria. From the health standpoint the object to be attained by making an examination of raw waters is to determine the probability of those waters transmitting disease. At present, chemical analyses can give no direct indication of this factor. Bacteriological analyses must be performed, but their usefulness will be limited until an exact and easy method of detecting typhoid bacilli in water is perfected.

The points considered in a chemical analysis are the color, the turbidity, the sediment and the chemical stability; the relative amount of insoluble substances in solution; the total solids and the chlorides; and tests are made to determine the proportions of the standards of ammonia nitrogen (free ammonia), albuminoid nitrogen (albuminoid ammonia), nitrite nitrogen and nitrate nitrogen, and the conditions termed oxygen consumed and dissolved oxygen.

The results of the chemical analysis are represented as parts per million, the equivalent of milligrammes per liter.

Pure water is colorless, and in many instances a highly colored water is objectionable only from the esthetic standpoint. A water may receive a natural coloration of a brownish hue when coming from a chestnut woodland or a reddish brown shade from a cedar or cypress swamp. A yellowish brown coloration may come from a grassy swamp. Coal deposits produce a gray and iron formations a red color. Many artificial colorations are found coming from tanneries, dyehouses, laundries, foundries and other industries.

Turbidity is translucent, whereas color in water is clear and transparent. Turbidity is due to finely divided particles of insoluble substances floating in the water, whereas the color of water is in solution. The suspended particles causing turbidity may have color, which, however, does not become dissolved in the water. The fine silt of clay produces a red or yellow turbidity, and pulverized red shale gives a terra cotta reddish appearance to the water.

The sediment is chiefly inorganic and consists of the mud which settles quickly upon standing. It is chiefly clay, shale, alluvium, sand or coal dust.

The nitrogenous organic matters found in water form the important chemical consideration of potable waters. These compounds are not stable, but undergo more or less constant alteration. In the presence of sufficient oxygen they form inert inorganic salts, but without available oxygen they will decompose into offensive gases and insoluble organic compounds. In waters examined in Massachusetts[1] the organic matter in suspension decayed in about seven days into free ammonia, and the latter about the fourteenth day disappeared with the formation of nitrites. At the end of three weeks the nitrites had reached their maximum, later being all converted into nitrates at about the end of the fourth week. These alternative changes are

[1] Dr. W. P. Mason: "Water Supply — Chemical and Sanitary," 1913.

most noticeable in water receiving some sewage. Such waters, sewages and trade wastes which may decompose into the offensive compounds and gases are termed putrescible. These waters which are not stable should be examined to determine how to prevent nuisances.

Free oxygen is contained in water or sewage in varying amounts which are available to react upon the nitrogen compounds. In raw waters the available free oxygen is absorbed from the air; it is to be found in the greatest amounts in mountain torrential streams; it exists in greater amounts in streams in wooded regions rather than in densely populated localities; its proportion is greater in the waters of rapid, shallow and broad streams than in slow, deep and narrow rivers. In heavily polluted waters it may be absent.

Free ammonia is found in excessive amount in waters from the bottom of muddy ponds, from swamps, in rain water, from shallow wells or sluggish streams containing much vegetable matter and in waters which have recently received discharges of sewage or slaughter-house drainage. Organic matters having undergone oxidization by filtration through sand or clay decompose into free ammonia. Nitrates in well water may be decomposed by the iron sulphide of the iron pipe to form free ammonia, therefore its discovery may not necessarily condemn the well water. Free ammonia comes from surface wash, in the proximity of cities, from within new iron pipes and peaty water. The proportions of free albuminoid ammonia depend largely upon the conditions of high or low water, upon stream concentration or stream dilution, upon the temperature of the waters and upon the presence of scums or other vegetable growths. When submitting a specimen to a laboratory for examination it is of the utmost importance to give in complete detail the above information relative to the surrounding conditions and influences, else the chemist may not be able to judge fairly and accurately respecting the water.

The chloride content of a water is quite strong presumptive evidence of sewage pollution when existing in large quantities not due to industrial discharges, to natural salt deposits or to proximity to the sea coast. Chloride is found in unpolluted waters from the proportion of 0.1, or less, up to 5 or 6 parts per million. A pollution of the water will increase this markedly, from 10 parts in a slightly contaminated water to 50 or 75 parts in a grossly polluted water. The presence of salt water in the well or of adjacent salt deposits would increase these proportions many times. The chloride content of unpolluted natural waters bears a direct ratio to the proximity to the seacoast. This is so definite that there may be drawn lines connecting the different sources of water found to contain the same amount of chloride, and these isochlors will show approximately a parallelism with the coast. This has been done in Massachusetts, Rhode Island, Connecticut, New York and New Jersey, the isochlors of one state being continuous with those of the adjoining states. The fact that wells or natural upland waters have a greater chloride content as they are located nearer the sea lies in the effect from storms and high winds blowing the salted mists and saline air landward from the sea. This spindrift reaches the water sources and wells, those in the most exposed localities receiving and analyzing to a greater salt content. As was shown in England by Barr,[1] those wells and ponds which are protected by mountains have a lower salt content than the waters more exposed. The direction of the prevailing storms will have an influence in forcing the salt mists further inland. In New York state and the central states determination of the chlorine content is of little moment without complete data, owing to salt deposits and deep wells. The character of the rock formations has an influence upon the chlorine content of deep wells, as shown [2] by Thresh. Wells sunk in

[1] William Barr: *Journal of Hygiene*, April, 1914.

[2] Thresh: "Water Supplies," 1896, p. 40.

early sandstone are apt to have a greater salt content than wells in limestone regions.

Standards for waters are not so important as their desirability may appear. Water should be safe rather than pure, and the limits of safety vary considerably under conditions. A chemical content which would pronounce safety for one water may declare pollution for another. The water from one class of wells is not comparable with that from another. There can be no exact dividing line between safety and danger as represented by a chemical composition. The term " polluted " is a complex term depending upon a number of correlated factors which influence the judgment of the analyst. A large proportion of chlorine when found in a water may cause the examiner to presume that pollution by sewage has occurred, and yet the salt may have gotten in by other means than sewage. Salt air or salt deposits may increase the salt content, so the natural percentage of chlorine in water varies. Beyond this, there can be no standard to represent the dividing line. If in one case a chlorine content of 7 parts signifies pollution and in another case 4 parts are present in a natural water, the question arises regarding the significance of 6 parts. It is thus with the other properties determined by the chemical analysis. To set a numerical standard for water would be equivalent to stating a definite degree of temperature which must be reached upon a certain date that the diagnosis of typhoid fever may be made. As with diseases, it is the symptom complex by which a water is pronounced safe or dangerous. Every specimen of water for analysis should be collected with great care, and with it complete data concerning the surrounding conditions and environment should be sent to the chemist. The accuracy of the opinion rendered by him is dependent upon the completeness of the information he receives. The report he renders to the sender of the specimen should not contain a long set of figures which may confuse him, but

should express a probable opinion, with necessary explanations.

Collecting a Sample for Analysis. — Unless sufficient care be taken not to accidentally contaminate a collected sample of water and without complete important data being sent with the specimen, the analysis cannot reveal the true condition of the water, and the chemist cannot give a reliable report or make definite recommendations. In collecting specimens the specific bottles which are obtained from the laboratory should be used. If none are supplied, a new two-gallon demijohn with a soft cork should be used. The cork should be boiled. The fingers should not touch the smaller end of the cork or the inside of the neck of the bottle. The demijohn should be partially filled, rinsed, emptied and refilled. The water collected should not include surface scum, but the water should not be filtered. The collected water should be kept cold and shipped immediately to the laboratory.

Data of water samples necessary to send with the water include: the date and hour of collecting sample; location and exact description of the character, kind and surroundings of the source of the water; a description of any possible sources of pollution; and a statement of the purposes for the analysis.

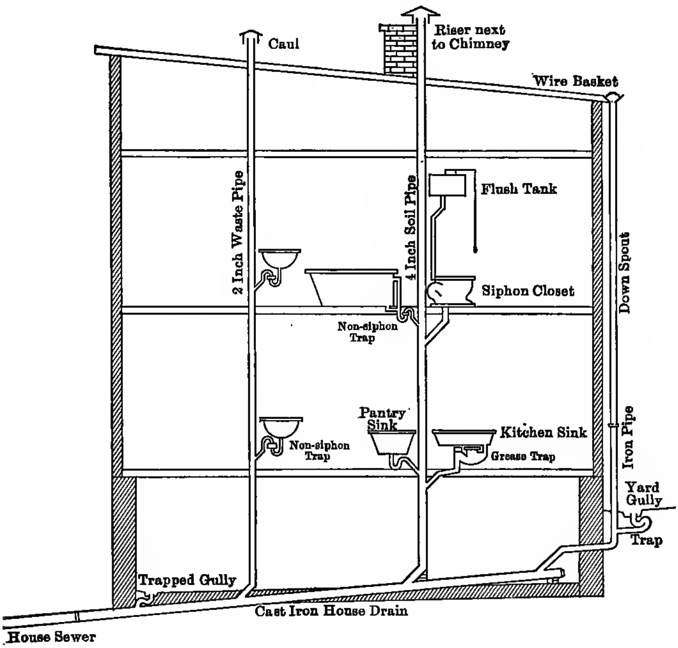
CHAPTER IX

SEWAGE DISPOSAL

Sewage represents the accumulation of waste products which are produced by the population and which in their raw condition when discharged can be of no value in the economy of the world, but which are eventually destroyed and rendered inert or useful. Organic matter naturally, therefore, decomposes or putrefies into harmless substances, and the putrescible factor of sewage is ultimately beneficial. Sewage always decomposes sooner or later, sooner through the artificial assistance of man, or later by the slow action of earth or water. When confined in a proper receptacle human sewage will destroy itself, the final products being some gases, a sediment of stable, inert chemicals and a clear brownish liquid which finally evaporates leaving a white deposit. Artificial treatment of sewage is a means to increase the rapidity of the chemical actions and a method to care for the final products. The subjection of sewage to some form of treatment is but the adoption of practical methods of increasing the rapidity of the biological destruction of sewage by the selection of those factors which are of the greater moment. To decide when it becomes necessary to assist nature in her destruction of human wastes is no small matter of easy solution. The methods to be adopted depend upon the amount and concentration of the sewage, upon the desired degree of purification and upon the available expenditure.

House Plumbing. — In the plumbing of houses there are certain practical requirements which should be included in city ordinances and in building specifications and the provisions of which should be enforced by plumbing inspectors.

The house drain and main riser should be of cast-iron pipe, not less than four inches in diameter, and should not be trapped at the house-sewer connection, but the main riser should be continued above the roof of the house to serve as a ventilator for the sewer. The basement floor should be cemented, with a pitch toward a trapped gully which is not



PLUMBING CONNECTIONS FOR A HOUSE

on the main drain but connects with it. All joints in the iron house drain should be lead calked. All connections between lead pipes and between lead and brass or copper pipes should be wiped solder joints. Between lead and iron pipes the joint is made by a brass ferrule. Putty or slip joints should not be tolerated anywhere. If the municipal sewerage is of the combined system the roof down-

spout may connect with the house drain in the basement, but should not be trapped unless the rain leader opens at the eaves near gabled or attic windows. All house fixtures connecting with the waste and soil pipes should be effectively trapped, and the kitchen sink be supplied with a very large grease-trap which can easily be cleaned. If roof down-spouts, or rain leaders, are built inside the houses, instead of being attached to the outside, there will be less difficulty from clogging by snow. The down-spout could serve as the main riser as well as for ventilating the sewer.

Sewer Air. — There is no such thing as a particular sewer gas. The air of sewers may contain various gases of decomposition, which, however, cannot produce disease and deserve consideration only because of their offensive odors. By having tight joints in the pipes, water-traps at all basins, tubs, sinks and toilets, and by continuing the house risers through the roof as open ventilators, the objectionable odors from sewer air may easily be eliminated. There should be no trap on the house sewer. Offensive odors arising from street sewers indicate faulty construction and call for cleaning and flushing.

Sewerage. — Sewerage is the system of street sewers, mains and trunk sewers which collects and carries the sewage to the treatment plant or final outfall. Some destruction of sewage occurs within the sewers, depending upon the time of passage. This includes some septic action, liquefaction or disintegration, and some precipitation by industrial wastes.

Municipal sewerage is laid according to the "separate" or "combined" systems. The so-called separate system provides one set of sewers to receive the house sewage and a separate system of storm drains to carry the rain run-off from the streets and roofs. In the combined system a single set of sewers receives both the sewage and the street wash. The separate system, when including the system

SEWERAGE SYSTEMS

Separate System	vs. Combined System
Sewers carry sewage only.	Sewers carry sewage and rain water.
Rain water collects in separate storm drains in double system.	Rain water mixes with sewage.
Rain water may flow only in gutters.	Used when rain water must not run over surface.
Best when sewage is to be treated.	Used more when sewage is discharged into a large body of water.
Sewage treatment plant would be smaller.	Greatly diluted sewage requires large plant.
Better for sewage farming.	Sewage too dilute after rains for farming.
Used with many unpaved streets.	When adopted, streets should be paved.
Roof water flows into gutter.	Roof water flows into house drain.
Small sewers usually require steeper grades.	Laid on somewhat flatter grades.
Velocity in house sewers constant.	Velocities increased after rains.
Minimum velocity 3 ft. per sec.	Minimum velocity 3 ft. per sec.
Harder to clean sewers.	May be entered for cleaning except in small upper ends.
Sewers always need artificial flushing.	Flushing by storms may suffice.
Sewers cannot be flushed by those street hydrants which wash only into storm drains.	Flushing done by street fire hydrants.
No sand admitted to sewer.	Street sand may block sewer.
Used when pumps are required for sewage.	Street grit injurious to plunger pumps.
No sewage odors arising from street inlets of storm drains.	May have sewage odors in street.
No danger from overflow of sewage into street after heavy rains.	Heavy storms may flood sewage into streets and cellars.

of storm drains, is the more expensive to construct, but may be an economy if the sewage is to be subjected to some form of treatment, since a smaller volume of sewage to be treated will require but a small plant. In the separate

system the storm drains receive only rain water, street flushings, the small amount of water from private or public lawn or street sprinkling, and perhaps some non-polluting industrial wash water. A comparison of the separate and combined systems may assist in the decision and selection of that system which is the better and more practical and applicable system of sewerage to be adopted by a local community. When both divisions of the separate system, two sets of pipes, are used the term "double" system is usually applied.

Sewers and storm drains should be laid at grades to produce a velocity to be self-cleansing. When this is impossible frequent flushing should be done. When sewer grades will permit, the catch-basins should be omitted. Bricked street inlets should be laid solid in cement mortar, and washed over with neat Portland cement to render them smooth and water tight to prevent pollution of the soil and the egress of rats from the sewers to the houses. Bricks which absorb more than 20 per cent of water are not suitable for sewer construction. The percentage of absorption is calculated from the weight of the dry brick and the same brick after soaking in water.

There are certain harmful substances which should not be admitted to sewers. These include heavy substances which will deposit and obstruct, as, lime from glue or other works, marble dust and machine shop sweepings; substances which increase the roughness and impede the flow, as, gelatinous deposits, grease, and hair; acid wastes which dissolve the cement and cause leaks; and hot steam or large quantities of hot water which will dissolve bituminous joints in pipe sewers or crack the pipe. Explosive gases should also be excluded from sewers. Factories or industries which discharge large quantities of wash water or wastes which do not contain any deleterious or putrescible substances which would be harmful to the water course into which the storm water flows, should be connected with the

storm drain, rather than the sewer, especially when the municipal sewage is subjected to some form of treatment.

SEWAGE DISPOSAL

The disposal of sewage is done by convenient discharge or according to some artificial method of collection and handling. The plan of disposal should be adopted according to those practical methods which are locally applicable for the prevention of a nuisance and for overcoming a danger. The system used varies with the number of people to be accommodated, a single family or a community. What may be termed convenient discharge results in either soil pollution or water pollution, both dangers to be avoided. Artificial methods include the use of some kind of sewage receptacle provided with an effective means of cleaning, or with sewerage. In either instance some means of treatment of the raw sewage should be adopted to render the sewage harmless and inoffensive. For individual residences tight privies or a small irrigating system, and for municipalities more or less complete systems of treatment works are desirable where disposal into water courses is a danger.

Sewage may be emptied into rivers when there is sufficient dilution to prevent the formation of a nuisance and when conditions of oxidation, sedimentation and time permit of complete purification before the water of the river is used for domestic purposes. It is usually conceded that a stream reaches its limit of contamination when the population in thousands discharging into it equals one-eighth of the watershed area in square miles. The dilution of the sewage by the river should, if possible, be 800 volumes, in order to prevent the river water becoming putrescible by the sewage.

The self-purification of water courses is the natural destruction of deleterious substances which find their way into the water. It is the slow method of Nature to provide against the accumulation of nuisances. It is dependent upon the destructive activity of bacteria and upon chemi-

cal alterations, requiring both time and oxygenation for its consummation. Under favorable conditions all bodies of water will eventually purify themselves by reducing their putrescible chemical compounds to stable solutions or precipitants, but no stream can be expected to overcome any nuisance which accumulates more rapidly than the existing natural forces can accommodate. There is a limit to the power of streams to destroy the sewage wastes which they may receive, and when this limit is reached a nuisance results. A nuisance is simply an indication of an overburdened natural force.

Streams from limestone regions and from cultivated fields will theoretically cause more complete purification of sewage than will soft waters from wooded regions. Sluggishness in a river of hard lime waters, and turbulence in a river of soft waters are desirable for theoretical efficiency in the self-purification of streams. In a river of hard water there will be greater chemical precipitation and a low rate of flow will assist in sedimentation. The destruction of bacteria occurs through death from starvation, and by sedimentation. The conditions of low temperature, low oxygen supply, sewage pollution, and lack of nutriment are not favorable for the growth of pathogenic bacteria.

Sewage should not be emptied into the sea or its estuaries when the raw sewage is apt to be carried by the tides to any oyster bed or bathing beach. When considering disposal of sewage by discharging into the sea a careful investigation should be made of the effects of the tides, winds and currents upon substances which float upon the surface, which drift in suspension and which move along the bottom. A careful study is made by using floats and sunken buoys; the direction and time of drift, with the effects of ebb and flood, are noted, as was done in the investigation by Mr. S. M. Gray, C.E., at Providence, R. I. The possible pollution of oyster beds is judged by the minimum time required for the sewage to reach the beds rather than by

direct mileage. Where pollution is suspected the oysters should be examined bacteriologically. Where there is any possibility of the raw sewage reaching oyster beds the beds should be condemned. No beds should be permitted where they are subjected to any exposure to a sewage effluent which has been treated unless it is certainly known that the treatment has produced complete purification and disinfection.

The most advantageous localities for the discharge of sewage into the ocean are at the mouths of rivers and big bays where the currents will carry the material far out to sea. The danger of the sewage being caught in eddies and drifted back to the beach should be guarded against. Since along the Atlantic coast there is a general southerly current, probably being a Gulf Stream eddy, with a tendency to a southeasterly drift, this should be considered in locating sewer outfalls. Theoretically, this implies the advantage of emptying the sewage on the north side of the mouths of rivers where there is a strong river flow; but where the discharge is sluggish, as from broad rivers, bays and inlets, a better distribution into the sea will be obtained by discharging the sewage on the south side of these bodies of water. These selections apply to such exposed coasts as that of New Jersey. The direction of the beach currents are shown by the direction in which the breakers travel along the shore. Under moderate winds or calm, ocean breakers maintain a general constant trend of being either parallel with or at an angle to the shore line, the point of first break being upstream.

SEWAGE DISPOSAL ON FARMS

The construction of methods for the safe disposal of human wastes upon farms is of great importance as a means to decrease typhoid fever, hookworm disease, tuberculosis, diarrheal diseases and other parasitic or infectious diseases. The method to be adopted depends upon local

conditions in each instance — upon the conditions to be met, upon the intelligence of the individual to be served, upon his financial ability to construct and upon his willingness and intelligence to maintain that system which is best suited for the environment and ground conditions. The primitive habit of depositing the dejecta promiscuously in convenient places is always a danger and should not be tolerated. The most simple system which has some semblance of improvement and safety is the dug pit, utilizing anything convenient for a seat. Primitive peoples should first be taught the advantages of the dug pit, rather than at first be directly advised to use some more elaborate privy which they will not build or use.

The Privy. — The open box privy, as usually built and located, is a nuisance, fly and food infection, ground contamination and frequently water pollution resulting. This toilet arrangement should be altered to include one of the improvements which will obliterate these dangers. The dejecta should be received in metal tubs, water-tight pits, leaching pits, cesspools, hydrolyzing tanks or some other equally efficacious receptacles. Besides this improvement, the housing of the privy should be made tight. The door should fit tight, vents and openings should be covered with netting to exclude flies, cracks should be filled, and over the rear should be kept closed a tightly fitting, hanging door, present for cleaning. The seats should be provided with covers which are prevented, by properly placed blocks, from remaining open at times when the toilet is not occupied. Open earth closets should not be installed within any residence.

The so-called sanitary privy is supplied with metal tubs or cans resting upon a wooden platform. When filled, the cans are removed and replaced by empty cans and the dejecta buried. This duty may devolve upon the incumbent of the house, or may be undertaken by licensed scavengers. Under some conditions of porous soil and where there is no

possible danger of contaminating a water supply, it may be advisable to build the box privy over an earth pit. When the pit becomes filled within twelve inches of the surface a new pit is dug, the privy moved, and the old pit filled with earth.

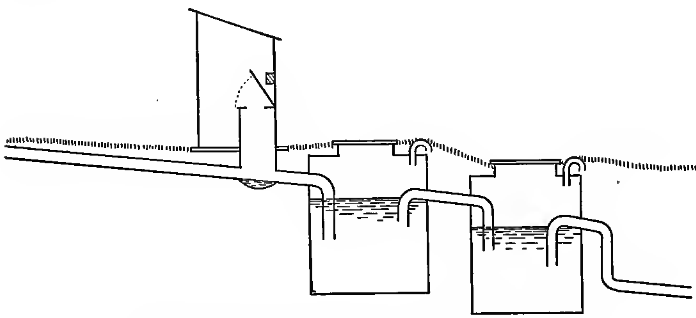
Water-tight cement pits may be constructed for yard privies where any ground seepage may endanger the water

OPEN PRIVY OVER A SMALL STREAM WHICH OVERFLOWS ON A STRAWBERRY BED

supply. They should be built shallow to require frequent cleaning. Dry earth should be thrown over the dejecta daily to absorb odors. No water should be allowed to accumulate in these basins unless an overflow with sub-surface irrigation is provided. Under the latter conditions the pit becomes a septic tank.

Individual septic tanks for hydrolyzing the excreta may be applied to the privies of rural houses. These are built according to the plan of the Kentucky tank; a concrete tank, about 3 feet wide and 6 feet long and 4 feet deep, is divided by a partition extending from the top of the tank

to within six inches of the bottom. Over one division is situated the closet seat; and from the other end an overflow pipe leads for some distance lying just beneath the surface of the ground. The drain pipe is laid with open joints. When the tank is first put in operation it is filled with water and three or four shovelfuls of stable manure, without straw, are added as stock to begin the nitrifying action. A bucket of water is then added weekly. The use of mechanical appliances, as splashers or panhoppers, with these privies results in failure and is not advised. The tank is roofed with tight movable covers to facilitate cleaning when necessary.



DOUBLE CESSPOOL SYSTEM FOR A RESIDENCE

Cesspools. — Cesspools are useful under certain conditions, but when wrongly located they may be a great danger. Cesspools should not be universally condemned. Old wells should never be used as cesspools or for the reception of garbage, drainage or rubbish, as pollution of the water supply will result. Cesspools are simply liquefying, hydrolyzing or septic tanks, as the various terms are applied. They should always be provided with overflow discharge pipes. They are built with unlined walls and leaching, or may be cemented in an attempt to make them tight. All cesspools are more or less leaching, hence none should be relied upon as absolutely water tight. Since all rough con-

crete is slightly porous, if it is desired to make the cesspool tight it should be painted over the inside surface, using a whitewash brush, with a very watery solution of neat or pure Portland cement. Several layers are applied, each one being put on before the previous layer has dried. Cesspools are built to be water tight when there is any danger of a contamination of a water supply, as judged according to the data given in the chapter on water supplies. If there is no water supply to consider, the cesspools may be built of open brick work or of unlined stone, to serve as leaching tanks. Cesspools should be built as a pair in series, one to receive the liquidated discharge from the other. The first cesspool soon becomes impervious from the kitchen grease coating the walls. Both the intake and overflow pipes of the tank should end in elbows leading beneath the scum surface. The elbow on the intake checks gases returning to the house and discharges the raw sewage beneath the sludge layer, where it belongs for the best anaerobic decomposition. The exit elbow prevents the sludge being carried into the next tank. From the distant septic tank the discharge pipe leads off as a subsurface drainage system. The discharged effluent from these tanks is liquefied, contains little or no solid matter, but is not purified or disinfected.

SUBSURFACE DRAINAGE

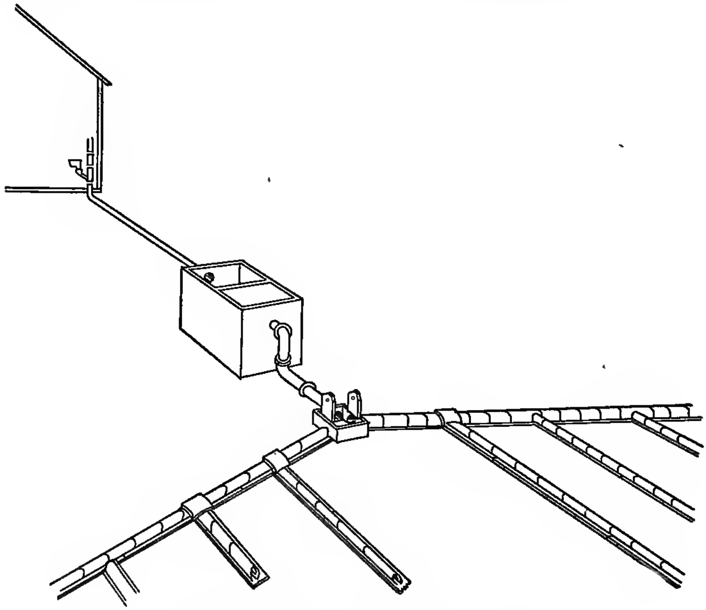
A subsoil drainage system is a series of tiles laid just beneath the surface vegetation. Agricultural tile laid with open joints, open brickwork, arched with indestructible roofing, perforated piping or other covered construction is suitable. The tile, which is preferable, should be laid upon boards in trenches about twelve inches deep. If laid in clayey or other impervious soil the trenches outside the tile should be filled with cinders or gravel. The object of the drainage system is to permit the septic effluent an opportunity to flow towards the surface to be acted upon by grow-

ing plants and by the bacteria which are found in the soil near the surface. If the sewage flows into open channels the system becomes one of broad irrigation or of sewage farming. An intermittent flow of sewage into the subsurface drains is advisable in order to allow for sufficient oxygenation of the soil. With private houses the discharge of water is apt to be intermittent owing to the periodic times of use. With large institutions there is a more or less constant flow, hence the drainage system should be provided with a discharge tank situated beyond the distant hydrolytic tank and equipped with an automatic siphon. Another practice may be the use of two systems of drain pipes leading from the same septic tanks, operated by hand gates or automatic valves, and receiving the discharged effluent alternately. The drain pipes may have a number of openings which lead up to the surface.

Tile Drains. — In laying the tile drains proximity to trees should be avoided, the roots of maple, elm, cottonwood, poplar and willow being the most troublesome. These roots have a tendency to grow into the drains, choking them. For ordinary porous soil one foot of 3-inch tile drain for each gallon of daily flow may be allowed; with clay soils, three feet. One acre of sandy soil should accommodate the sewage from 140 people; fifty linear feet of tile drain should be sufficient for the ordinary family of five or six persons, under suitable conditions. The slope of the tile drain should be from four to six inches in thirty feet. Yard toilets may be located over the house drain leading to the hydrolytic tanks (according to the illustration), the toilet discharging into a cement depression in the house drain.

Subsoil drainage is applicable for residences, institutions and factories. Where the daily flow is greater than 2000 gallons of sewage, surface irrigation or some form of artificial bed treatment is advisable. With residences if there is not sufficient available land for subsurface drainage, and if contamination of the ground water is to be guarded

against, the effluent from the hydrolytic tanks may flow automatically and intermittently by siphonage, into coke



SUBSURFACE TILE DRAINAGE SYSTEM

contact beds. In such instance the sewage is introduced into the contact beds from beneath and withdrawn by an automatic siphon after two hours' contact.

SEWAGE FARMING

By applying raw or treated sewage to specially constructed farms there may be a crop yield which will help to compensate for the expense and at the same time offer an inexpensive method of disposing of sewage. The sewage flows into trenches dug into the natural ground, percolates into the top soil and is nitrified by soil bacteria and absorbed by plants growing between the ditches. The ditches

are dug about a foot in depth and from three to five feet apart. They should be provided with board gates so that one channel may be used while others are blocked off, resting empty. The land selected for sewage farming should be well drained, in some cases underdrainage may be necessary. The ideal land is a coarse sandy loam surface overlaying gravel or sand. Before applying the sewage to a farm it is more satisfactory if previously septicised and liquefied in a hydrolytic tank and settled. Since there are times when not all the sewage can be accommodated on the farm, as during wet weather, a method of receiving and treating the excess should be provided.

The plants raised upon a sewage farm should be selected according to their ability to absorb moisture and to the avoidance of danger to the consumers. There is much danger in growing cabbages, turnips, rhubarb, celery and similar vegetables when manured by human sewage; therefore such farming should be prohibited. No fields of berries, melons, asparagus or even root vegetables should be cultivated under fertilization by human or domestic sewage. The plants raised upon a sewage farm should be limited to forage crops, as fodder, carrots, beets, mangels, rutabagas, soy beans and other vegetables intended only for live stock; and also grains, especially Italian rye, grass or hay, alfalfa, barley, clover and corn. Plants with runners are not adapted to these farms. The nurseries for growing leafy bushes and soft wooded trees would make excellent sewage farms.

BROAD IRRIGATION

Broad irrigation is the application of raw or treated sewage to the natural soil in which a partial purification is accomplished. The ground serves as a natural sand filter-bed, the result being a straining out of the insoluble substances, a bacterial nitrification, an oxidization and a final percolation of the liquid to the ground water. It differs

from sewage farming in that in broad irrigation there is no expected destruction or absorption of the water by plants, and no crops are raised. In sewage farming only so much sewage is applied to the land as will be beneficial to the plants; in broad irrigation the quantity applied is governed by the amount the soil will purify, regardless of any effects upon existing plants. In farm irrigation one prime object is the profit to be derived from the crops raised; whereas in broad filtration the purification of the sewage is the only consideration. In farm irrigation a much larger area is needed to dispose of the given sewage; in broad filtration the ground may need more preparation, as grading and underdraining. In either case intermittent dosage is better than continuous.

During winter, to prevent freezing of the bed it may suffice to plough deep furrows. If the land is only slightly porous flooding to a depth of one or two feet may prevent freezing, especially if the sewage is warm. Broad irrigation is applicable where land is cheap and sufficient acreage is available; where pollution of the ground water cannot contaminate any water supply; and where any nuisance created will not be objectionable. Porous soils rather than clay are more adapted to this purpose.

The trenches in fine sandy soil should be one foot wide, two feet deep and spaced five feet between centers. They are nearly filled with coarse sand which filters out the sediment so the sewage can penetrate to the fine sand below. The surface of this trench sand has to be occasionally removed and renewed. By building these trenches this size the filtering surface equals the entire ground acreage, yet only one-fifth of the area (that within the trench) needs cleaning of sediment and of snow and frost. The trenches may be covered with boards to advantage. The trenches have a slope of from 1 : 1000 to 1 : 50. If coarse sand is beneath and poor filtering material on the surface the trenches are cut through the upper layer. With coarse dry

sand below, no underdrains are necessary. With this plan of broad irrigation there should be filtered 130,000 gallons per acre per day in sandy soils.

The amount of sewage which may be applied to broad irrigation (Gerhard) would vary from 25,000 gallons per acre daily of strong mixed sewage to 100,000 gallons of greatly diluted sewage, when applied to the best soils, as light sandy loam overlaying gravel or sand. Heavy loam or clay should receive not over 10,000 gallons of strong, or 50,000 gallons of weak sewage.

SEWAGE WORKS

The system adopted for the artificial destruction of sewage constitutes a sewage treatment plant; and should not be termed a purification plant since the final product as obtained is not pure water, although it is possible to obtain an effluent which is drinkable and safe.

Since the dangers from the pollution of water supplies by sewage are so great, and the risks of improperly operated treatment plants so numerous federal and state control of the waterways and sewage treatment plants are advisable.

The essential parts of sewage which demand consideration are the unsightly solid masses and floating waste particles, the dangerous bacteria and the offensive putrescible organic matters. The treatment comprises various methods to eliminate these contents from the final effluent. The floating waste particles are removed by screening and the heavier stable solids by sedimentation. The solid fecal masses are disintegrated by digestion by anaerobic bacteria confined within a tank constructed to exclude air. The bacteria become mutually destroyed by antibiosis or by starvation, are removed by filtration or killed by disinfectants. The organic matters which become offensive through putrefaction and the formation of gases are destroyed by the absorptive action of aerobic bacteria which are encouraged

in their nitrification by being provided an excess of oxygen in specially designed porous beds, the contact or sprinkling filters.

Choice of System. — The various kinds of works are used either as individual plants or in such combinations as the requirements demand and the existing finances permit. Succinctly stated, although each kind of treatment bed has its special adaptations and advantages, the putrescibility of sewage is probably best overcome by the contact beds, the bacteria are best removed by the sand filtration and the power of sewage to absorb oxygen from the river water is best overcome by the sprinkling filters. Beyond these features the kind of process or combination of processes adopted depends upon many factors, including availability of land, of sand, and of head of sewage, and funds.

The requirements made upon a sewage treatment plant should depend upon local conditions, upon the disposal of the final effluent and upon the use of the water supply which ultimately receives the treated sewage effluent. The demands put upon a small stream which becomes a domestic water supply, upon a large river filtered before use, upon a tidal estuary and upon a lake water are very different. Therefore any sewage effluent discharged into one of those bodies of water would necessarily, for safety, be of quite different composition than that desirable in another instance. There can, therefore, be no general set standard put upon treated sewage effluents, which are reasonable and practicable. In one case a nuisance is to be avoided and in another a danger. The nuisance would arise from a high content of putrescible solid matter; the danger from disease would be the result of a high bacterial count. The preservation of fish should also be considered, from economic, commercial and sportsmanship standpoints. Sewages which absorb much oxygen from the natural water courses and also certain trade wastes destroy fish. The treatment of the sewage should provide against this damage.

The degree of purification by treatment plants is, therefore, elastic, and requires a previous knowledge of the condition of the river receiving the effluent, with the rate, volume and condition of flow determined. Watson suggested[1] that the designer should aim to produce a sewage effluent that would not putrefy on being kept seven days at 80° F.; that would not contain more than 3 parts per 100,000 of suspended solid matter; and one that would not absorb oxygen from the stream into which it flows. To which should be added, that the effluent shall not increase the Bacillus coli content of the river water beyond 2 per 100 c.c. at delivery at the next consumers.

Screens. — The screens are iron rods, fixed or movable, usually inclined at an angle and extending above the surface. The screen intercepts the large masses of floating matter, paper and sticks, kitchen wastes, some fecal matter and other animal or vegetable substances. There may be a revolving mechanical device for collecting and removing these substances. Fine screening is very essential and important.

Sedimentation Tank. — The grit chamber or detritus tank is a large compartment into which the raw sewage is discharged after leaving the screens. The coarser, heavier particles here settle to the bottom and are later removed by emptying the tank; or by water pressure forcing the sediment through underdrains. The grit consists mainly of sand, rags, bones, paper, coffee grains and similar substances. It dries quickly when spread upon the ground, and should be used for filling or be buried. Sedimentation tanks are used also for collecting the precipitate formed in the chemical treatment of sewage, and for intercepting and collecting the sludge sediment found in the hydrolytic tank.

[1] John D. Watson, C.E.: *Trans. Fifteenth International Congress on Hygiene, Vol. IV*, 1912.

HYDROLYTIC TANKS

Hydrolytic tanks, the so-called septic tanks, are used to produce a more complete disintegration and liquefaction of the suspended matters floating in the sewage. They have the combined effect of a destruction of the obnoxious putrescible solids and a separation by settling of the inert, stable inorganic compounds. They do not purify the sewage or possess a bactericidal power. Their effluent may have a higher bacterial count than the influent raw sewage, but will contain fewer typhoid bacilli. Their specific usefulness is to offer the anaerobic conditions essential to the growth of certain sewage organisms and to give the added time of storage necessary for fecal destruction. Their effect is to more quickly bring the sewage into a condition to be nitrified, and may cause a considerable reduction in suspended organic matter and the separation of fats. Their chief usefulness is in the liquefaction of the suspended solids, especially of the scybalous masses, but less than one-half the suspended solid matters are destroyed. The action is more rapid and complete with warm sewages or in warm weather. When the sewage contains considerable grease the tanks show better effect if built two in a series, one tank emptying into the other. Such duplication is advisable when the tanks are used for the sewage of a private residence. The adoption of hydrolytic tanks for municipal usage is required when the raw sewage contains much solid human excreta and when the time of flowage within the sewers has been short. It is advisable for the excreta to be broken up before entering the tank. If there is sufficient fall this action may be accomplished by cascades or water falls at the outlet of the sewer.

Hydrolytic tanks should be covered to cause a more rapid destruction of the upper parts of the scum layer, to prevent a nuisance from odors and to check fly breeding. In the Massachusetts investigations it was shown that experimentally there is no difference between the open and closed

septic tanks as far as the effluent was concerned, since the sludge layer converted the open into the closed tank. In some tanks there is, however, little or no surface scum. Since hydrolysis is caused by anaerobic putrefactive bacteria it is necessary for air to be excluded from the floating sludge layer if it is desired for this sludge to quickly decompose and liquefy. Therefore, the sludge should be collected, not upon the surface of the liquid but under roofing partitions which are situated below the surface. The gases emanating from septic tanks come from the decomposing sludge and sediment and should be intercepted by gabled partitions, collected in pipes and burned or liberated.

The raw sewage flows directly into the hydrolytic tanks without previous treatment except coarse screening. The suspended particles of the sewage form what is known as sludge. The undissolved masses either float to the surface forming the scum or the heavy particles gravitate to the bottom to form the sludge. The scum is formed chiefly by fecal masses of low specific gravity, but gas formation is also a slight factor in floating the masses or the scum on the surface. Upon breaking up the scum layer part of the mass will sink. The liberation of gas is but a small factor in this settling. It is desirable to remove the gas which forms and collects within or beneath the scum. This may be done by hand or mechanical agitators, or by intermittently lowering the water level and having the scum broken up by resting upon horizontally placed cross-bars. Where the scum is collected under partitions beneath the surface there should be provided gas vents which begin as coarse wire net flues below the scum. If sufficient fall is available the sewage may flow with considerable fall on top of the surface scum layer, to keep it broken.

Septic decomposition takes place throughout the tank, the greatest amount occurring at the lower portions of the sludge layer. The evolution of sulphuretted hydrogen and carbon dioxide probably occurs at the sludge surface, and

that of methane and nitrogen at the bottom of the tank. The amount of sludge collecting in the tank varies with different sewages. If so much collects as to necessitate cleaning the tank every few months larger tanks should be constructed. In some instances the small amount of collected sludge sediment does not necessitate removal more often than once in five or more years. Each tank is a problem unto itself and must be so considered.

The size of the hydrolytic tank should depend more upon the amount of floating sludge than upon the amount of sediment, for it is the scum which blocks the pipes and overflows into the other parts of the plant where it is not wanted. Yet the scum should remain within the tank to digest and liquefy, and not be removed and spread upon the ground, creating a dangerous nuisance. Where the sewage is very fresh and contains much organic matter floating or in suspension the sewage should be divided to flow in numerous tanks, or the one tank may be built broad rather than long, and so constructed to intercept all insoluble substances, but to provide for not over eighteen or twenty hours' capacity of flowage. A capacity for twelve to fifteen hours' supply is most satisfactory. The length of sewerage to the nearest contributing house and main supply would have an influence upon the size of the hydrolytic tank. There is some septic action occurring within the sewers, and with a flow rate of 3 feet per second, equaling about one and a half miles per hour, the mileage of sewers would be considered. The usually adopted size, however, is one of twelve hours' capacity.

Compound tanks are built for the purpose of conveniently collecting the sludge sediment. In some cases the tanks are built in two-story design; the sediment of the upper tank falls through openings in the floor and reaching the lower compartment is digested there. In other instances the sediment is removed from a flat or troughed bottom, draining by pipe to a sedimentation or drying tank. Re-

cent design constructs the bottom of the septic tank as one or numerous hoppers, into which the sludge settles and from which it is removed by water pressure when the valves are opened.

Imhoff Tank. — The Imhoff tank represents an evolution of the septic tank, the stages of development being represented by numerous wells or other construction. The Imhoff tank is simply an improved septic tank which simplifies removal of the sediment and provides for a retention of the gases. The Imhoff tank digests and liquefies the sewage; it does not purify the sewage or render it innocuous, nor does it destroy the bacteria. The effluent from the Imhoff tank should not be emptied into any stream which should not receive raw sewage on account of the resulting nuisance or pollution. The base of the tank is an inverted cone into which the insoluble sediment gravitates. From beneath the apex of the funnel a pipe leads to the ground surface, and through this pipe the settled matters are forced by excess water pressure. The tank is further provided with overlapping, horizontally placed, oblique baffle partitions which check the upward passage of gas bubbles. The sludge collects beneath the partitions which offer more complete anaerobic conditions than are found in the ordinary septic tank in which the sludge is brought in contact with air.

Sludge. — To determine if a hydrolytic tank is constructed and working properly or is the size best adapted to the sewage, the condition of the scum, of the sediment and of the effluent must each be considered. The scum should not contain sand or other heavy particles; it should not be infested by fly larvæ. It should not be too thick, nor dry or buoyant. It should show that it is decomposing and occasionally becomes immersed, the heavier sludge particles settling to the bottom. Freshly discharged sewage masses should not be resting upon a solid scum layer, but should flow into the tank into the water or below the

scum layer. In open tanks if it is desired to retain the scum intact it may be coated over with a thin layer of loam.

The sludge sediment is the chief consideration of a septicising tank. Good sludge is alkaline in reaction, black from the formation of ferrous sulphide and does not have a marked or especially disagreeable odor. Unripened sludge is alkaline, but is only grayish in color. If sludge remains within the tank too long it becomes sour and of acid reaction, assuming a yellow or yellowish gray color, and having a bad odor. Upon removing the sludge sediment from the tank the color is noted, and if signs of staleness appear the draining should be more frequent. If this sludge is black and easily drained of its water it has been withdrawn at the right time, especially if the water draining from it is comparatively clear and colorless. When withdrawn too soon the sludge drains and dries with difficulty. The ripe sludge may be withdrawn and dried in the open, creating much less odor than the scum and not being very attractive to flies for breeding.

The effluent from the hydrolytic tank should not contain floating fecal masses or much fine undissolved particles.

Sludge Disposal. — The disposal of the sludge forms one of the most important questions in sewage treatment. The two problems depend upon the amount of water and upon the putrescibility of the sludge. The water content of sludge may be very great and require mechanical pressers for large plants like that at Providence, R. I., and elsewhere. Filter pressers are probably only available for that sludge which is collected by chemical precipitation, through the use of alum or lime, since the colloids of fresh sewage will quickly choke the filter fabric. By pressing sludge hot or when chemicals are added, the tension activity of the colloids is prevented. Centrifuges may be used for the removal of water from sludge, but are expensive. Dry sludge may be mixed with refuse and burned. The fresh sludge may be mixed with ashes and used for filling. The manurial

value of sludge is not great, rarely rendering an economy. Attempts to recover the grease from ordinary sludge have been unsuccessful because expensive. For small plants natural evaporation from the spread sludge may suffice, but the greater the grease content of the sludge the slower will be the evaporation.

SAND BEDS

An artificial adaptation of the principle of sewage purification which occurs when sewage is deposited upon the ground, is obtained by the construction of filter beds of sand. Sand filtration is the best method of sewage treatment. The beds consist of about three feet of clean, fine sand upon the surface, resting upon two feet of coarse sand and overlaying graded gravel, the larger sizes resting upon a layer of small broken stones. The whole bed is about four or five feet in depth, and well underdrained. The beds must be of uniform texture, porous, and the sand when applied be free from organic matter, sticks, leaves and loam. The surface is nearly level, having a slight fall of about 1 : 200 to permit even distribution of the applied affluent. If the beds are properly constructed and maintained, and receive a sedimented liquefied sewage subsequent treatment may not be necessary. As much of the suspended matter should be removed as possible before applying the sewage to the beds.

Cleaning should be done systematically. This includes a scraping of the surface or a removal of the top inch with systematic raking. If the sand is very fine trenching may be advisable. Trenches of several inches in depth are dug and filled with coarse sand. If the beds are apt to freeze before a heavy fall of snow, the digging of deep furrows may prevent the freezing of the entire upper crust.

The sewage flows over the surface of the sand, an even distribution being effected by flowing it through perforated or open troughs. The sand beds are used intermittently,

sufficient periods of rest for oxidation being allowed after each application. The rest periods should be about four hours and the time of being flooded, two hours; the sand filter may be dosed twice a day. A bed of fine sand may receive 30,000 gallons of crude sewage or 60,000 gallons of septic sewage per acre per day, and a bed of clean, coarse, sharp sand, twice these quantities. Sand beds should receive only

SAND BEDS FOR SEWAGE FILTRATION
Liquefying tank in the distance

thoroughly liquidated and settled sewage. The sand filtration may be used in conjunction with contact beds, receiving the effluent after it comes from the contact beds. Coarse sand filtration is used as a preliminary to percolating filters.

Sand filtration is applicable to sewage when a high bacterial efficiency is required and when the avoidance of odor is not essential, and when turbidity rather than putrescibility of dissolved organic matters is to be avoided. A

sand bed should remove about 90 per cent of the bacteria but may approximate 99.9 per cent removal; and should remove between 97 and 99 per cent of the organic matter, and yield a colorless effluent which is generally clear. The effluent may, however, be odorous and contain unchanged organic, dissolved compounds. The disadvantages of sand filtration for sewages include the great size of beds required and the expense of cleaning.

SAND FILTERS VS.	CONTACT BEDS
Give best results.	Not so efficient.
Remove nearly all bacteria.	Bacterial efficiency less.
Effluent clearer.	Effluent has considerable suspended matter.
Effluent nearly colorless.	Colored and turbid.
Effluent has much odor if filter is overloaded.	Less odor.
Effluent less putrescible.	Much more putrescible.
Requires large area.	Smaller area necessary.
Rate of filtration low.	Higher rates used.
Necessary to clean surface more often.	Less frequently cleaned.
Also used for precipitated factory wastes.	Used for putrescible wastes after becoming septic.
Used intermittently.	Used intermittently.
May be used after coke beds at high rates.	Double contact in series advisable.
Sewage should be settled if possible.	Sewage always settled first.
Rates, 30,000 to 50,000 persons per acre per day.	May accommodate 1,000,000 persons per acre.
More expensive to build.	Less expensive to construct.
Less expensive to run.	More expensive to conduct.

CONTACT BEDS

As a means of affording a double action in the one bed, rendering a certain high purification, which seems applicable to certain sewages, treatment beds of broken stone for intermittent flushing have been adopted. These beds apparently effect both an anaerobic and an aerobic action, the

submergence in the absence of oxygen preceding the oxidizing action. The beds are flooded with sewage, remain filled two hours, are then emptied and undergo a resting period of four hours. When filled there is probably a partial activity of the anaerobic bacteria. During this time of submergence the solids in suspension adhere to the gelatinous deposit which has formed upon the bed stones. The aerobic bacteria, recently stimulated by aeration during the preceding resting period, may also be active, as they are during the resting period. When the bed is drained, the water of the sewage is replaced by air which has the opportunity to oxygenate the bacteria and oxidize the chemical compounds.

Contact beds are built of coke or broken stone or broken brick, porous coke being the best material and broken stone the most commonly used. They are built in duplicate, to be used alternately, one bed being in use while the other rests empty. Contact beds are more effective when built in series for double contact, the effluent from one bed being later subjected to another bed which provides for more complete nitrification. The liquid capacity of a contact bed at first is about one-half the total cubic capacity, but after use this soon becomes reduced to about one-third, caused by the settling of the material into a more compact mass, by the introduced sewage bodies filling the interstices and by the growth of the gelatinous layer on the stones. The beds should receive their dosage quickly by hand gates or by automatic siphonage from a settling tank, the sewage being distributed over the surface by wooden or, preferably, perforated tile troughs. If the sewage contains much floating debris or fecal masses the beds may have a better effect if filtered from below, as the masses are retained submerged anaerobically where their disintegration is more rapid. Cleaning such beds would be expensive.

The operation of the biological processes acting in certain sewage treatments — in sand beds, irrigation, farming, con-

tact beds and sprinkling filters — requires that the sewage be applied intermittently in order that the bacteria within the beds may have sufficient opportunity to obtain their required oxygen. In continuous filtration, where the beds are constantly submerged in sewage, no oxygenation of the bacteria would be possible. Those beds which hold air within their meshes may be used at longer intervals of dosing. If a bed be constructed of terra-cotta plates raised upon underturned edges, which would provide for withholding upon their undersurfaces a film of air, the bed could be operated at much longer intervals and at higher rates, having the effect of intermittent aerobic treatment. Such a bed would be of the order of the Dibdin beds of horizontal strata of slate separated and supported by bricks, being applicable for certain sewages, and is hereby suggested.

Automatic siphons are patented devices, or may be constructed by using a pipe of small diameter shaped as an inverted ∩, the second arm or that one more distant from the flush tank being considerably longer than the arm into which the sewage first flows. All siphons require occasional attention and should be built to be easily cleaned. All mechanical appliances, especially those having movable parts, are liable to err and get out of order, and require frequent attention.

SPRINKLING FILTERS

Sprinkling or percolating filters are beds of broken stone over which the septic, settled sewage is delivered through sprinklers, the water falling as rain or spray, to provide for complete oxidation by the air. The beds are not allowed to fill with sewage, but the influent, discharged continuously or intermittently by the sprinklers, trickles down over the stones to the underdrains. The sprinklers work automatically and are movable or fixed. Movable sprinklers maintain an intermittent action by working on a track for

traveling or as a perforated pipe moving as a revolving radius over a circular bed. Stationary sprinklers, as used in America, consist of upright pipes projecting about a foot above the surface of the filter bed, at intervals of eight to ten feet, each pipe surmounted by a brass sprinkling nozzle. With stationary nozzles the sprinkling by automatic siphonage is intermittent, the spraying requiring about five minutes at fifteen minute intervals. The stone beds, vary-

SPRINKLING FILTER

ing between five and ten feet in height, are built above ground. If built without solid retaining walls greater ventilation is permitted. Since a free supply of air is desirable it may be advantageous to retain the stones of the filter by large stones, by open brickwork or concrete lattice. If a higher degree of bacterial efficiency is required than that afforded by the percolating filters their effluent should be subjected to sand-bed immersion.

The sewage is sprinkled in order to be oxidized, and the finer the spray the more complete will be the oxidation. It

is therefore desirable to use spray nozzles which produce a very fine spray. A fine spraying nozzle is clogged very easily by the solids in the sewage; therefore, if fine spraying is to be done the septicised sewage should be thoroughly settled and then filtered through sand filters.

The advantages of trickling or percolating filters and contact beds may be summarized in the table as given.

CONTACT FILTER VS.	SPRINKLING FILTER
More acreage necessary.	Smaller in area.
More easily choked up.	Little danger of clogging.
Size of stones smaller, $\frac{1}{10}$–2 inches.	Bed stones larger, $\frac{1}{2}$–3 inches.
More frequent cleaning.	Cleaned less often.
Some odor from filter.	Nearly as much odor given off.
Fewer flies.	Flies abundant.
Less nuisance created.	Should be built far from residences.
Effluent has considerable suspended matter.	Contains less suspended matter.
Effluent has more odor.	Less odor in effluent.
Requires but small "head" in sewage.	More "head" required.
Easier to operate in cold weather.	May freeze. Bed protected in cold climates.
Heavy rains overtax filter.	Can withstand an overload by heavy rain.
Double contact best.	Single bed will suffice.
Single beds worked twice a day, double beds three times a day.	Spraying done several times per hour.
Rates depend upon concentration of sewage.	Higher rates permitted.

Disinfection. — The disinfection of sewage becomes an essential method of a practical and more or less economical means of preventing pollution of water supplies, shellfish beds and bathing beaches. It is not so applicable to fresh raw sewage as to septic, settled or otherwise treated sewage effluents. Individual experiments should be carried out in each case to determine the most practical and efficient method of disinfection of the particular sewage, and to de-

termine the times and degrees of chemical and bacterial variations and the required dosages. The plant should be so designed that the period of contact between the sewage and the disinfectant will be sufficient to secure a reasonable and satisfactory bacterial reduction, but it should not be expected that the treated effluent will be sterile. A practical dosing device is needed to automatically increase or decrease the flow of hypochlorite solution or chlorine parallel with the variations in the sewage flow. The disinfectant used is chlorine or calcium hypochlorite. The plant must be operated intelligently, with constant supervision, that no accident may occur. The orifice through which the bleach flows should not be so small as to be clogged by particles of undissolved hypochlorite or scum, nor should any metal apparatus or machinery be exposed to the corrosive fumes which constantly arise from the calcium hypochlorite. The bleach dosing device should be constructed of brass, lead, zinc or glass; the chlorine regulator is constructed of silver and glass. If a disinfection plant is to be used in connection with a sewage treatment plant it should be located to receive the sewage effluent after it has been treated by the other measures. Sewage should not be disinfected before it goes into the hydrolytic tanks, or before it is subjected to the sand filters, contact beds or sprinkling filters. It is the effluent from the last of the series of treatment works which receives the disinfecting agent. Industrial sewage in general need not be disinfected.

Chloride of lime is usually employed as the disinfectant for sewages, the dosage depending upon the degree of concentration of the sewage and the reduction required. Phelps has shown[1] that practical disinfection may be obtained when using bleach in the proportions of 8 parts of available chlorine per million parts of settled sewage, 13 parts with septic sewage and 3½ parts for sprinkling filter

[1] Earle B. Phelps: Geological Survey, *Water Supply Paper*, No. 229, 1909.

effluents. Clark and Gage[1] obtained reductions between 75 and 90 per cent in the bacterial count in sewage by using 3.8 parts of available chlorine, and complete sterilization by 37.5 parts per million. For sand filter effluents they state 7.5 parts per million are necessary for 75 per cent reduction in the bacteria.

TREATMENT OF FACTORY WASTES

Offensive trade wastes when discharged into streams, ponds or lakes become a menace to the consumers of the water, create a nuisance and are destructive to fish. Harmful factory wastes should be kept out of streams and so treated that no nuisance or damage to the stream will result. Industrial sewage and factory wastes produced within a city having sewerage should be emptied into the municipal sewers, in most cases, even though the sewage is to be treated. In rural localities the conditions frequently demand the treatment of the sewage and wastes of isolated factories. The establishments producing the damaging wastes should provide satisfactory methods of treatment which will meet the existing requirements that the water courses are not befouled. In such cases the factory sewage should be added to the industrial wastes and subjected to the same treatment unless the recovery of a by-product is desirable.

There are no methods of treatment which are generally applicable for all industrial wastes, but the character of the waste is considered in devising a method of treatment which will be most efficient. Chemical neutralization or precipitation, sedimentation or straining, or bacterial disintegration are the general principles considered. The method to be used is adopted upon experimental evidence.

Bleach Works.—The acid wastes are added to the bleach liquors in settling tanks. Sand filtration is used.

[1] H. W. Clark and S. De M. Gage: "Experiments on Disinfection of Sewage," 1912.

Brewery Waste. — In cities the wastes should be discharged into the city sewer. For rural establishments the best treatment is by land irrigation after a neutralization by lime. Percolating beds are preferable to contact beds for this work.

Cardboard Factories. — To the wastes, calcium superphosphate, monocalcium phosphate, is added and, uniting with the free lime present, precipitates and settles with the suspended matter, according to the researches of Sjollema. The dry sediment may be used as manure.

Cloth Factories. — Effluents containing much fibrous material may be conducted into a revolving drum which is covered with wire netting of one millimeter mesh for retaining the fiber. Much wool or shoddy may be saved by this method.

Creameries. — Settling tanks of two-day capacity, followed by discharge into a river may suffice. Intermittent sand filtration (22,000 gallons per acre per day) or land irrigation following liming or disinfection by chloride of lime in settling tanks may prove satisfactory. In broad irrigation not over six gallons per square yard should be applied, and in sand filtration the rate should not be over 1,000,000 gallons per acre per day (3 feet of depth of applied effluent), according to Guth.

Coal-mine Wash. — The drainage from washing coal or quenching coke may be discharged into rivers. Sedimentation and neutralization may be required.

Dyehouses. — A method for complete purification has not been solved. Partial decolorization by precipitation by iron and lime or other chemicals, followed by sand filtration, may be adopted. Within cities the dye waters should be discharged into the public service.

Gas Works. — Radcliffe has worked out the following method:[1] The suspended lime is removed in settling tanks,

[1] J. Tillmans and H. S. Taylor: "Water Purification and Sewage Disposal," 1913.

after which the water trickles over plates in a fractionating apparatus into which is blown a hot blast of exhaust gases containing carbon dioxide and air. The dissolved lime is precipitated and the phenols destroyed. The lime is separated in a tank, and in another tank receiving the water a stronger stream of air removes the phenols, and added sulphuric acid removes the sulphocyanides.

Paper Mills. — The main effluent is the alkaline water from the boiling vats. Coarse sand filtration may suffice, or coke beds may be used.

Slaughter-houses. — Partial purification may be done by treatment with iron or sulphate of alumina, followed by sedimentation. Screening followed by broad irrigation is satisfactory, but the screens must be kept clean and the intercepted material buried or burnt; the irrigation ditches must frequently be reploughed and given sufficient time for nitrification. If the drainage flows constantly into a ditch the soil becomes impervious, losing its power of absorbing and purifying the sewage, resulting in a nuisance and fly breeding.

Soap Factory. — Milk of lime is automatically added in amounts determined experimentally, and the treated sewage flows into a large clarifying reservoir containing baffles. Thence the effluent flows by a cascade into a second sedimentation basin, preferably of large acreage, and thence upon sand filters. The use of septic tanks or contact beds for soapy sewages is inadvisable.

Starch Works. — Sedimentation tanks are best; the effluent neutralized with lime may be subjected to contact beds.

Tanneries. — These effluents result from the liming process, the dye liquors and the tanning liquors. All tannery effluents are putrefactive and harmful. They should not be discharged into sewers receiving brewery wastes. The three effluents may be discharged into one reservoir to effect a partial clarification. In some cases chemical pre-

cipitation is advisable. For more complete purification septic tanks and broad irrigation are satisfactory. Double contact beds are better than percolating filters for this work, but before using them the arsenic and other poisonous chemicals must be removed. The wastes may be made to flow very gradually along trenches which contain a layer of sawdust. The solid particles settle upon the sawdust and, with it, are later burned, according to the method of Tolman. Tannery wastes will create a nuisance if the effluent is allowed to rest in a settling tank without being kept in motion.

Wool Scouring. — The wash water is worked alone; screened and then acidified with sulphuric acid and heated. Upon standing, the fat separates in sludge from which it is expressed by hot filter presses. The effluent may then be subjected to subsurface irrigation, or to double contact beds.

REFUSE DISPOSAL

The proper disposal of refuse is for the purpose of preventing nuisances, and can have little effect upon public health. Refuse is composed of garbage and rubbish, but not night-soil. Ashes, street sweepings, dead animals and snow are other classes of city refuse. Garbage includes kitchen wastes, discarded fruits and vegetables from stores, and butcher shop trimmings. Rubbish, in its method of handling, may be classed to include waste paper, boxes, broken furniture and other discarded house furnishings, tin cans, and stable manure as well as ashes, discarded bricks and other building materials. The satisfactory disposal of the various kinds of refuse depends upon local conditions and the amounts to be handled.

Garbage. — Garbage may be burned by the householder, but usually a nuisance is created. It may be collected by private or public scavenger. All scavengers should be licensed, the license to be revoked under improper handling of the collected wastes. The garbage may be collected to

be buried, to be fed to hogs, to be mixed with ashes or dirt and used for filling, or be tried out to recover by-products, or be incinerated. The disadvantages of the burial system for garbage disposal include the difficulties encountered in frozen ground, long hauls, expense of the large amount of land required, expense of trenching, fly nuisance and the acidity of the soil which is produced. At Columbus the garbage was buried in trenches one foot deep, 1000 tons or

GARBAGE COLLECTION SERVICE USING SEPARATE CANS

1681 cubic yards per acre. It took from two to two and a half years for the used land to again get into condition to receive more garbage.

Hog feeding, with private or public collection, is satisfactory in small towns, but no butcher trimmings from non-inspected meats should be fed to hogs. Public collection under license may be let for the purpose of conducting a hog farm. These hogs are bred and slaughtered. Although hog feeding by garbage has been condemned by the Los

Angeles courts and elsewhere, it is employed in a number of places, and with satisfaction. At Denver 75 hogs were required for one ton of garbage. Some method of sorting the garbage is necessary to prevent the pigs getting stale, moldy or decomposed garbage and to keep all rubbish out of the feeding troughs. Probably only under unusual conditions and a very high price of pork could the feeding of garbage to swine be made to pay the whole cost of collection.

Reduction may be profitable; it is sanitary; it offers employment. The disadvantages are the expense of machinery, the offensive odors (which should be minimized by exhaust fans leading to air washers); the skilled labor required, and the necessity of collecting the garbage separately or of sorting it at the works. In reduction, some system of rendering the garbage is undertaken to recover the grease and oil, the final dried tankage being used as a base for fertilizer.

Garbage may be mixed with four or more volumes of ashes or earth and used for filling. Garbage should not be deposited in any lake or water course. The dumping of garbage at sea cannot be considered a satisfactory final method of disposal.

Incineration of the garbage may be accomplished by drying and burning, or by mixing it with combustible substances. Incinerators may be constructed of horizontal grates or rods upon which the garbage dries, subsequently dropping through to be consumed. The garbage may be dried in horizontal drums containing Archimedian screws which churn the drying garbage toward a coal fire which supplies the heat for drying. When mixed with ashes for burning, ash screenings retained by a quarter-inch screen may be used. The heat from the hot ashes of the destructor should be utilized to assist in the drying process.

Garbage should be deposited by the householder in covered metal cans. If the garbage is collected separately and collections are not made more often than twice a week

the householders should be encouraged to wrap the daily supply in paper, except when the garbage is for hog feeding or is to be tried out for by-products. If the garbage is to be mixed and handled with ashes the paper wrapping will be a disadvantage.

Rubbish. — Rubbish is handled according to local needs and opportunities. It is used for filling, is burnt or picked

BURNING THE WASTE PAPER IN THE CHICAGO ALLEYS
A satisfactory method

over. Sorting to recover parts is usually not profitable. Sorting before incineration may be necessary. If the proportion of combustible rubbish is sufficient the garbage may be mixed with the rubbish and the whole mass burned in an incinerator. Coal may be needed only for starting the fire. The heat generated by the burning rubbish should be utilized. At Savannah the destructor which burns the refuse produces sufficient steam to run the pumping plant.

Manure. — Manure should be used for farm fertilization where practical. Composted manure is more adapted for this purpose than fresh or dried manure, but when stored for composting the manure should be so handled that its valuable salts are not wasted or that the manure will not become a nest for fly breeding. Unless it can be properly

STREET FLUSHING BY HAND IS EFFECTIVE AND OFTEN CHEAP

handled composting should not be attempted. Stored manure should be kept under a water-proof roof, since rains will wash away the valuable manurial salts. Manure may be stored in tight receptacles or be piled only upon a grating which holds the manure above the ground, giving the bottom of the pile good ventilation. The grate may be of heavy iron rods, narrow planking stood on edge or a double layer of fence rails over which is thrown some brush.

This grate will markedly decrease fly breeding. Within cities, stables should be equipped with concrete vats kept tightly covered and cleaned weekly. The average horse may be said to yield 30 pounds of manure and 8 pints of urine daily, or half a ton of manure a month. A ton of manure is about 93 cubic feet, occupying a space 3 by 5 by 6 feet.

CHAPTER X

HYGIENE OF THE HOME AND FACTORY

The three factors by which people are subjected to the dangers of disease are other people who are infectious, impure foods which may transmit disease, and living and working conditions which permit or induce the development of disease. These phases of life are of nearly equal importance and each must receive that attention which will ameliorate the specific dangers or will break that influence which maintains the predisposing cycle of risk. Unhealthy conditions in one abet unsanitary opportunities in another. The avoidance of physical strains or bodily injuries under one condition increases the resistance which may overcome unforeseen dangers in another. Impure foods are less debilitating if body resistance is at its maximum. Resistance to disease is affected by the methods of living, and correct living will help in large measure to overcome the dangers of occupation. Industrial risks are lessened by improved methods of working and improved designs of machinery. Occupational diseases may largely be eliminated by avoiding exposures to unhygienic conditions and poisonous substances.

HOUSING

Housing deals with the problems of obtaining better conditions under which people live. It entails the necessity of practical laws efficiently administered. The inspection of living conditions and of the manners and habits of those classes of society most affected by bad housing conditions becomes a preface to the work of instituting improvements and reforms in houses, yards and streets. The housing

problems of the large cities center around the poorly constructed houses with unhygienic surroundings and are established in the ignorance of a public which does not know how to live the best under existing necessary conditions of poverty and congestion.

The questions of housing are simple but multitudinous. They relate to the conditions under which a man spends his existence. The purpose of the science of housing is to investigate these conditions, to determine which have a deleterious effect upon the man's health, comfort and efficiency, and to practically solve the problems of correct living or to make practical suggestions which will benefit the man to avoid the damaging conditions. Housing considers the periods of sleep, of eating, of working, of recreation and of rest. The conditions of the bedroom — the ventilation particularly, but also the lighting, cleanliness and the exposure to disease-infected rooms — are considered. Congestion is a relative term of indefinite value. Healthy people can sleep or work within a small compass, or many people within a small room, with perfect safety to comfort and health provided sufficient ventilation is maintained and enough lighting is given. But in tenements and certain other buildings using natural ventilation a legal requirement of a definite number of cubic feet of capacity per occupant is advisable. The place where a man eats, the condition and care of the food, the milk and water, the infestation by flies or other vermin, the cleanliness of the eating utensils and the freedom of the cook from infectious diseases are all more problems encountered in housing investigations. The size, condition, cleanliness and use of the back yard form important factors which should unite to develop healthy children. The sociologist does not judge a man's premises by the front yard or his children when dressed for exhibiting, but inspects the back yard and the influence it exerts. The cellar is the fourth most important part in judging the health conditions of a house. The

construction, the dampness, the cleanliness and lighting, and provisions to guard against rats and vermin are considered. The factory or office in which the man works, the church, hospital, court-house, jail or other public building to which he may go are investigated. The influence of the schools or playgrounds upon the health of his children and the effect exerted on his health by any amusement place, store, resort, public conveyance or public highway are included in the broad subject and study of housing.

Slums. — Slums, as long as they remain slums, are constant dangers to the whole of the city. Their carriers of disease are constant disseminators of infections; their accumulations of filth are degrading examples of a sordidness which penetrates all classes; and the whole atmosphere of primitive carelessness becomes a check upon civilization, making the proper education of children and the elimination of disease more difficult and more costly.

The elimination of slum conditions depends first upon the enforcement of effective laws to prevent the future construction of alley residences, of yard toilets, of dark room tenements, of fire traps, of small rooms, unventilated hallways and unfinished cellars, and without adequate provision for garbage, ashes and sewage disposal. The name "alley" as applied to small residential or industrial streets should be discontinued. Small streets at the rear of residences should be kept clean, all streets and passageways being paved.

The existence of slum conditions depends primarily upon the primitiveness of peoples who are living more than a century behind the present standards of civilization, and these conditions are permitted or encouraged by certain men who build, own or legalize construction which degrades or endangers life. To modernize a district is an expensive proposition but each public improvement made should be made with the idea of permanency and be of the best.

Tenements. — The evils of the tenements are chiefly evils of occupancy — unhygienic methods of living rather

than improper building construction. The enforcement of effective building ordinances will not accomplish as much as educational work carried on by a corps of visiting nurses. The people of the tenements need first to be shown how to live and how not to abuse the quarters provided for them. Builders should be compelled to design their houses that the occupants can remain healthy if they choose. Toilets situated within bedrooms are unsanitary and corrupt morals. An insufficient number of toilets provided in the alley to serve many families is unhealthy. The great work for housing reform is not enforcement of laws but effective public education. The poor, the aliens and the congested districts are permanent fixtures. It is for the other people, with ability and authority, to show the oppressed how to live best under the inevitable environmental conditions of poverty and congested quarters. The poor must be given proper houses but they also must be taught how to live. Occupancy conditions which are evils include the keeping of boarders in the family bedroom, the hoarding of rags and rubbish, keeping in the bedroom dirty cats and chickens, the promiscuous throwing of garbage and ashes upon the floor or wherever convenient, allowing rats and other vermin to populate the flat, the overcrowding of beds and refusing to open windows for ventilation, and eating and sleeping within the workroom. Many families block up the windows and stairways with boxes, boards or rubbish. In these houses a twofold danger is added when laundry work for outside families is done in these tenement rooms.

Placards tacked up in the tenements by the health department will do some good. They should be brief, should state specific orders or advice in regard to methods of living or give one-line abstracts of the laws. They should be printed in the language spoken, but since the greatest offenders are usually the most ignorant and illiterate very much cannot be expected from placards. The visiting nurse is the mainstay.

The question of tenements versus individual houses is largely one of economy. Tenements should be replaced by individual houses, if this be practicable. Large cities require many workmen and, generally speaking, large industrial and manufacturing plants can more advantageously be operated when situated at large railway centers and near the other factories and stores upon which they are dependent for supplies and a market. With the universal greed for more pleasures and luxuries the price of necessities constantly rises; therefore, economy is to be practised along other lines. This economy, not rightfully but actually, tends to drive the workmen to live near their work and to decrease the workmen-owned individual homes. The building of the little house with a yard, which constitutes a real home for the workman, is to be encouraged. It means a more healthy neighborhood, purer air, healthier and happier children, less smoke evil, but it also means many dollars and extra hours spent in travel to the place of employment. Individual homes require many miles of streets, requiring great expenditure and higher taxes for street paving and street cleaning, and for the laying of water and gas mains, sewerage and electric conduits. With openly spaced individual homes there is less necessity for park systems and playgrounds than in congested districts, but in all developing districts of municipalities just as much property as possible should be acquired early for parks and playgrounds.

Tuberculosis is the basis of the greatest of the housing problems. The great proportion of house transmission of tuberculosis, the ease of family infection, the utter disregard of all hygienic principles of living practised by the tuberculous and the methods of cure and prevention of the disease make it of the utmost importance for the home living conditions of each person with tuberculosis to be investigated. It is permanent municipal economy to send visiting nurses into the homes of those tuberculous families who are not under proper medical supervision, that the

various members who are infected may obtain the proper education describing how to protect themselves and others.

A special clean-up day may be started in the spring to induce householders to overhaul their premises and get rid of all rubbish, but the public should not fall into the rut of waiting for the annual clean-up the following spring. The public should be encouraged to clean up weekly or every day the ash man comes around. The people can be notified of the regular rubbish-collecting days. Where the ashes and rubbish are not placed at the front curb for collecting, the householders can be given distinctive cards to display at the front windows to notify the ash men of the premises which require their services.

Hotel Inspection. — Hotel sanitary inspection depends upon the size of the town, upon the geographical location and the social grade of the hotel for the particular points to be investigated. Hotels vary greatly in their appointments. In rural hotels certain particulars, as water supply and sewage disposal, would be noted, whereas in cities different qualifications would receive attention. Scoring hotels on the score card basis is of little consequence as hotels are not competing in a way that any little improvement gained in a score will affect business. Hotels should be inspected to note evasions of the laws and to reveal unsanitary conditions which may be abated through the persuasion of the health officer if not by legal orders from the inspector. Where any suspicious or dangerous condition is found to exist every endeavor should be taken to have it removed. No important question, as that of the safety of the water supply, should be passed only upon a haphazard guess as the lives of people may be put in jeopardy. The exact conditions should be learned.

The points to be observed in hotel inspection may be generalized to include principally: the source of the water supply and the use of common drinking cups or of bubbling fountains or individual glasses; the safety of the method

of sewage disposal; methods taken to avoid or abate flies, noxious odors, dust, unsanitary or unsightly garbage or rubbish piles; the use of individual or of dirty roller towels; the means taken to protect food supplies from insects, cats, rodents and dust; the methods of sweeping and dusting; the efficiency of ventilation and lighting; the means, efficiency and condition of fire escape methods and extinguishers; the frequency of supply of fresh clean linen in the rooms and in the dining room; the abundance of linen supplied and the size of the individual pieces, especially the sheets; the cleanliness of and protection given the bedding; the quantity and quality of the soap and toilet paper; the quality of the food and the methods of its preparation; and the means taken to control the infectivity of the patrons or employees to prevent one person spreading any disease to the others. The presence and use of dark rooms, without windows, is an important subject. Dark rooms, without windows, being without ventilation and light, are therefore conducive of tuberculosis when used as bedrooms. Such use of these rooms in hotels and tenements should be prohibited, and the placing of a bed within a windowless room be subject for prosecution.

Boarding houses, lodging houses and tenements all need inspection and supervision along similar lines which apply to hotels.

Rural Housing. — Important problems of country houses include the locating of buildings with regard to topography and the geological formation. Dryness of flooring, proper surface drainage, the avoidance of odors or drainage from barnyards or other contaminating places, proper sewage disposal, avoidance of polluting all streams, and the preservation of a pure water supply are all housing problems to be worked out for each rural or suburban home. Houses and other buildings should be so located and built that their cellars or ground floors will not be damp. Dryness of ground floors and basements is affected by selecting as a

house site elevated locations, locations over porous soil with the water-table far beneath the surface, or upon a sloping, well-drained surface. The effect of dryness may be augmented by subsoil drain pipes to intercept the subsoil water on the up-hill side of the house, or by drains built below the house to drain the soil of its water. Roadways built upon the up-hill side of the house to drain away surface wash will help to keep the cellars dry. Rain water from the roof in some cases will keep the cellars damp unless prevented. Where there are encountered prevailing winds, barns, pig pens and manure piles should all be kept to the lee of the house. Cleanliness observed in the barnyards and pig pens (clean, dry yards are always possible) will do much toward overcoming offensive odors. Much shrubbery, as trees, between the barnyard and house will slightly decrease the odors. The problems of how a rural home can most satisfactorily dispose of its drainage and how it can most surely select or preserve a pure water supply are dealt with in the chapters upon those respective subjects. The discovery and supervision of typhoid carriers upon farms are of the greatest importance to prevent these persons infecting any milk, butter or other food they send to market.

FACTORY INSPECTION

Factory inspection usually combines two distinct activities which should be separated. Instituted originally as a means to enforce labor laws it should be subdivided into health supervision and labor inspection. In cities and wherever public health work has been put upon an efficient basis with whole-time officers, the factory inspectors should be superseded by health supervisors and labor inspectors. In small towns and in many rural districts it is still necessary for one individual to handle both activities; but where this plan of separation is applicable different men should be intrusted with the separate duties, one inspector under the health department and the other inspector working under

the factory bureau of the labor department. The labor inspector is needed for the enforcement of a labor law which should be comprehensive and thoroughly scientific. Such a law would provide for the proper employment of proper individuals. The labor inspector's duties would be to collect statistics and tabulate data relating to child labor, the hours of work of women and children, the specific work done, the provision for escape from fire, the means for fire prevention, the provision for proper toilet facilities and wash rooms, for seats and rest periods for women, the establishment of periods and provision for relaxation and recreation and the adequacy of salaries. This work of labor inspectors may advisedly be reserved for women. The work is chiefly tabulations and could be undertaken by recent school graduates.

The other work of factory inspection, the health supervision, relates solely to the prevention of accidents and disease. This work requires the ability to diagnose occupational disease and to search its cause; it demands an engineering knowledge of how to detect possible causes of accidents and to suggest such changes as will prevent the accidents; it requires the ability to detect unsanitary conditions and to order changes; it embraces the inspection of water supplies and methods of sewage disposal, with the supplying of practical schemes to improve these conditions; it requires the ability to detect and to correct the common factory faults of dust, dampness, poor lighting and insufficient ventilation. The study and elimination of occupational diseases, including those due to industrial poisons, is the great duty of the supervisor.

The work which needs to be done, and which can be accomplished by an efficient service under proper centralized leadership, would demand that the factory health supervisor be versed in the various branches of sanitary science. The inspector should be able to diagnose infectious diseases; he should understand how these diseases are trans-

mitted. He should know which occupational conditions cause, induce or maintain the various occupational diseases, and how these conditions may be remedied. He should be able by inspection to anticipate where accidents are apt to occur and be able to suggest or design practical preventive measures. The detection of faulty building construction and the determination of practical improvements are his duties. He should be able to detect the effect upon the efficiency of the workman exerted by the influences of lighting, ventilation, room capacity, overcrowding, dampness, excessive heat, noxious odors and harmful dusts. The factory inspector should be an efficiency expert, but only so far as to determine the effect exerted by conditions of work upon the health, comfort and ability of the workman. His is not the work of designing or improving machinery or of determining the peculiar fitness of a man to do his particular job. His work is not to determine if a certain man measures up to his job, but if there are industrial conditions under which the man works which are harmful to him or to his ability. Finding harmful influences, the factory supervisor should correct them. Factory inspectors investigate the existence of any occupation, process of manufacture or method which is injurious to the health of adults or minors. The inquiry relative to the lighting of factories and workshops considers the kind of work done; the acuteness of vision and the concentration or degree of attention of sight required; the kind, amount and distribution of light; the frequency of eye-strain and the number of employees wearing glasses; the frequency of eye injuries and what is done to prevent them; the types and extent of other injuries and the reasons and methods of their production; the intelligence of the workmen and the interest shown by the employer toward the employees.

Factory inspectors should receive from the health officer lists of the reported cases of tuberculosis having employment in certain specified factories or workshops in which

the kind or conditions of work could have had some influence upon inducing the development of the tuberculous process. Where a case of the disease develops during or after the man had worked in one of the suspected employments, efforts should be directed to prevent the other workmen from becoming affected by the same conditions. Also, when a man with tuberculosis is reported to have been working at some employment or in some places in which the other employees may have been endangered by the infectious man, an inspection of the premises to procure a thorough cleaning of them is essential. Where a tuberculous workman has been manufacturing or handling certain products which may become infected and consequently are a danger to the customers, the instance of such infection of commercial goods should be reported to the proper authorities that steps may be taken to protect the customers.

In investigating the influence an occupation may have upon the health of the employees the previous condition and class of the employees must be considered. Certain trades, as cigar making or tailoring, attract or receive weakly, narrow-chested phthisically inclined people because they are unable to obtain more vigorous employment. These trades thereby have high tuberculosis death rates, although the trades should be no more unhealthy than banking, which has a very low rate. Robust men break down in one occupation and slip into another trade and die. It is the former work which is responsible for these deaths; the necessity of including past occupations upon sickness and death reports is apparent. A study of death certificates, therefore, becomes of great value when work in industrial conditions is begun in any community. But since occupational diseases do not all result in death it is of utmost importance to consult the case records of physicians, dispensaries and hospitals to learn of the health effects of various occupations of a given community.

A study of the hygienic conditions of a separate industry

in a given community, or of a single factory, will frequently reveal the necessity of some special changes being made in the industry or factory. It will be shown what particular part of the industry, what particular substance used in the occupation or what special method or condition of work is having a deleterious effect upon the workmen. A careful study will show that some change in operation will increase the comfort and efficiency of the employees, and that the change, even though provisionally costly, will be a business economy.

Industrial Investigations. — The method of investigating an industry and its hygienic effects is comparatively simple. The employees of the industry may be exposed to certain industrial activities in which there is a risk of accident and in which some special kind of accident frequently occurs. In some other industry the employees, or some of them, may be exposed to the dangers of fumes, of dust particles, of large particles of substances thrown off forcibly (as in grinding or sand-blasting) or they may be working with irritant or poisonous chemicals. The method of investigating the hygiene of these exposures and of instituting measures for their relief will be taken up separately and briefly. Where an industry is investigated every available factory of that particular industry is visited and the total effects are compiled. An industrial investigation is made to determine the hygienic effects of some particular phase of that industry, but the inspection of a separate factory or establishment is a careful survey of all details which relate to the health efficiency and working powers of the employees of that one plant. Industrial investigations should be conducted by federal, state or municipal officials as being public health measures. The hygienic inspection of an individual factory may be made by a private consulting sanitarian as this work is a commercial proposition and a proved economy for the employer. Industrial investigations form a duty of public health officials.

In making an investigation of the hygienic effects of some condition or substance of industry the investigator visits each establishment making, using or adopting the particular method or substance under observation. The work should be done only authoritatively. The cooperation of all employers and employees is essential to secure trustworthy results. At the mill or place investigated the number of employees is obtained, grouped as men, women, boys and girls. The number of those working with the substance or under the condition investigated is learned. The amount of time lost through sickness or accident is obtained, and the specific cause of each absence together with the loss in wage and the loss in productiveness is tabulated. Each of these individual employees is watched at work. Careful observations are made of each detail of the methods of work, and where necessary physical examinations and interrogations of personal conditions, family history and home environment are resorted to. When the investigator notes any infringement of the principles of hygiene or sees any carelessness or thoughtlessness on the part of the employee the attention of both that employee and the employer must be drawn to the particular need for a change. Any exposure to danger should be learned and the necessary changes be suggested at once. Every endeavor should be made to have the employer institute those changes which will benefit the employee, and the workman should be required to adopt measures or apparatus which are for his self-protection. These generalizations will apply to practically every industrial or working condition investigated and needing improvement.

In making an investigation of the general hygienic conditions of an individual factory or establishment the sanitarian first makes a cursory inspection of all rooms to determine in which parts detailed and minute investigations are required. Then general features, as ventilation, lighting and cleanliness, are taken up for all parts of the

buildings. This is followed by special inspections which relate to the particular work done in the factory. Where a special condition is deemed faulty, suggestions should be made to show what improvement will give the best practical results.

If a room is found poorly ventilated some simple scheme may provide adequate natural ventilation. Certain windows may be opened, and not others; it may or may not be advisable to use deflectors inside the open windows, or board deflectors on the outside properly placed may in some instance increase the ventilation without affecting the lighting. A flue, built on the outside wall, leading from a certain window may give the desired change of air. Perhaps a certain kind of artificial ventilation is required. The artificial propulsion of air may, in some instances, be accomplished by one or more electric fans appropriately placed. A more or less complete system of artificial ventilation may be desirable. The health inspector should suggest what particular system will give the desired result, recognizing the advantages of recommending the least costly improvement, but it is not within his province to design the system, or to calculate the size of the blowers or ducts or to estimate their cost.

In investigating the lighting facilities the inspector should determine how the facilities on hand can be made more effective. The work tables may be rearranged in the room, or the work which is done upon them may be so altered, or the places of the employees changed, that they may get a maximum of light. It may be shown that the artificial lighting is not properly placed to give the maximum of light where it is needed on the work. The electric lights may be raised or lowered, shielded from the eyes or provided with reflectors, increased in number or relocated, to the advantage and efficiency of the workman. It may be shown that the best and most economical lighting system has not been adopted. Under certain conditions the

natural lighting facilities need changing. An outside, opposite wall may need painting white, prism glass may or may not be an advantage in the particular place, or ground glass or translucent window roller-shades may be an improvement. It may also be shown that the employer has refused to resort to artificial light as a supposed economy when his lack of foresight not only strained the eyes of his employees but decreased their output.

Other points of management and workmanship in which the health supervisor of a factory can produce greater efficiency in the employees are countless. They all rotate around the axiom that factory health is factory efficiency. Efficiency is the synonym for output, and business output or increased commercialism appeals to the employer.

The arrangement of the hours for doing particular jobs should be made according to the times of greatest powers of the workmen. A workman is most capable, vigorous, careful and able to perform exacting work, especially mental work, in the first half of the morning. His powers are next at their height in the middle of the afternooon, next in the early part of the afternoon, then during the latter part of the morning and toward evening he shows exhaustion. The ability of the child varies according to the same periods. These divisions of time should be considered when giving people their duties to perform, since their best work will be done when their condition is best, and as their condition decreases in tone they should then begin the less particular, less exacting and less strenuous work. A person given a change of occupation during the day will be able to perform better and more creditable work, especially if outdoor work be interspaced with indoor labor.

Occupational fatigue is to be avoided. It results usually from too long hours, night work, or from speeding up; it may occur as a result of the decreased muscular power of old age or because young undeveloped persons are put at too arduous labor; it may be the final result of bodily strain

resulting from attempting to work efficiently in dusty atmospheres, under imperfect lighting, with poor tools, under distracting noise or in excessive heat or cold, dampness or dryness. Fatigue may be an inherent result of some condition in the workman, as poverty, ill health, alcohol, worry or the inability to properly conserve or control his powers. In investigating the efficiency of workmen these factors should be considered.

The sanitary control of tenement workrooms includes the licensing of each individual workman. Each applicant should report in person to the proper authority who should determine if the person has open tuberculosis or any other disease which may be transmitted through the goods going out from the workroom. The license should be renewable within a specified time and be granted only to those who are known not to be a danger to the customers. The head of each tenement workroom should be held responsible for the help he employs, and for proper lighting, ventilation and cleanliness. A card record system of all tenement workrooms is desirable, the index to show the pertinent data of the specific work done, of the employees, the sanitary conditions and the licensure. This card index is referred to in checking up the cases of communicable diseases which occur in the districts.

OCCUPATIONAL DISEASES

There is a distinct need for the investigation of industries to determine the location, the cause, the treatment and prevention of occupational diseases. This work will increase the efficiency and output of man, besides increasing his happiness and prolonging his life. An occupational disease may be a systemic effect from the absorption of some poisonous chemical; it may be a local reaction from contact with an irritant. It may be the result of faulty environment, as poor lighting, or be caused by excessive dampness or heat, or be induced by dusts, by noise or by

jarring or vibration. Faulty posture or strained positions, improper seats or the lack of some kind of guard or protector, careless or improper methods of work or some other unusual method of working or environmental factor to which the worker is unaccustomed may cause or induce in him an abnormal physical condition.

Defensive measures should be adopted where applicable. The use of eyeglasses, goggles or cobalt glasses will save the eyesight where required. Rubber gloves, rubber or leather finger guards, special head gear, special apparel and heavy rubber boots all have their particular usefulness. Machinery guards, dust hoods, improved machinery and methods of carefulness will save many lives, preventing accidents and disease. The workmen should be made to realize the necessity of carefulness, and they should receive the necessary instruction. Everybody should realize the necessity of safety first. Furthermore, workmen should be penalized for carelessly taking unnecessary risks and also should be protected by an adequate workman's compensation law.

Industrial Poisons. — The absorption by the human system of various chemicals used in the industries frequently produces symptoms of more or less severity. The term "industrial poisoning" is used to cover these reactions. The list of chemicals which are included under industrial poisons is constantly increasing under extended investigations. With the discovery of the cause and the invention of methods for preventing poisoning the number of cases rapidly decreases, provided efficient supervision and education are given, as with lead poison, or provided legal enforcement is enacted, as occurred with phosphorus poisoning. Factory health supervisors should be acquainted with the various forms of known industrial poisoning that they may institute practical means of prevention. The occupations in which these cases of poison may occur are multitudinous; suffice it to note that where a certain poisonous

substance, as lead, arsenic, benzene, turpentine, wood alcohol, or some local irritant or caustic is employed, the results should be sought.

The absorption of industrial poisons takes place through the skin, by swallowing, by inhalation or the reaction may occur as the result of local irritation. The avenues of absorption vary with the chemical and with the form or usage of it to which the workman is exposed. Lead may be absorbed through the skin, as in painting; by swallowing, as may occur with plumbers or type setters; or by inhaling lead dust or lead fumes. As with lead, so with other poisons the particular avenues through which they gain entrance into the system must be determined that poisoning may be prevented. Not only is it essential to know the means and avenues by which industrial poisons enter the body, but their local and systemic effects in both the acute and chronic stages should be known as well as the effective treatment to be given these cases. The effect of the absorption of one of the industrial poisons may be immediate, as with cyanide accidentally swallowed by silver platers, or it may have every gradation of insidiousness up to the slow development which may occur in tar or paraffin workers who occasionally develop skin cancers after working many years in the hot substances. This latter condition is classed as an occupational disease rather than a poisoning.

But relatively few persons who become exposed to the various industrial poisons develop symptoms in consequence. Those who do show evidence of absorption may have a special hypersensitiveness, a susceptibility or idiosyncrasy. Upon searching industries but few cases of poisoning may be found, but they should be discovered, cured and protected from further poisoning. If a personal factor leading toward poisoning is found a change of occupation should be recommended or required. Where the method of ingestion is known (and it should always be determined) measures should be taken to check the exposure

by altering the conditions of workmanship to protect future workers. This may mean the substituting of a less dangerous chemical — desirable but rarely possible. It may require the wearing of masks, respirators or rubber gloves. It may demand the enforced frequent cleansing of the hands, under penalty. It may mean the entire change of method of work. The protection of the workmen is of paramount importance and the work should be shaped to fit the men.

The opportunities for industrial poisoning are multitudinous; suffice it to mention here a few of the dangerous occupations in which these important industrial poisons confront the workmen.

Lead poisoning may occur in those working in lead smelters, in paint and varnish factories, in rubber works, on file cutting, in china, pottery or earthenware. It may attack those working as glaziers, plumbers, painters and tile makers; also type makers, or tinsmiths and others who solder. It may come from the soluble lead used in enameling tubs and other ironware, from the red lead paste used in making storage batteries, from the fumes arising from lead kettles in pipe works or at linotype machines, in vehicle and automobile factories, from leather varnishing, from dyeing and printing, and from the glazing of many kinds of papers. Those also who work at glass cutting and polishing, in making artificial flowers or cheap jewelry, and those who work in weighted silk are more or less exposed to lead poisoning.

Arsenic poisoning may occur among paint grinders, among taxidermists, among the manufacturers or handlers of Paris green, and also among those employed in the manufacture of substances in which arsenic is used as a pigment, in wall papers, cretonne or other printed cotton, cloth, colored paper boxes and artificial flowers. In the manufacture of certain highly glazed paper, as for playing cards, arsenic is used.

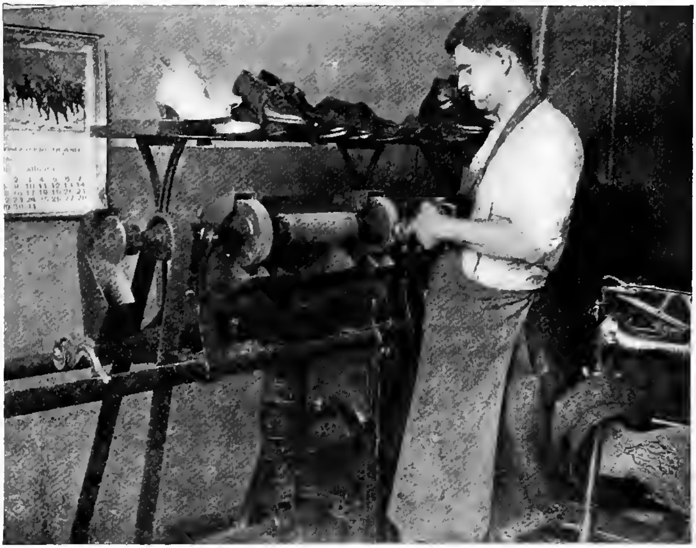
Mercury poisoning should be sought among thermometer makers, and among those who make felt hats, electric meters, gilded and silvered ornaments, mirrors and among others working in amalgamating processes.

Industrial Dust. — Dust and other fine particles of substances expelled into the air in the manufacture of various articles of industry are chiefly of concern in their connection with causing or inducing the development of pulmonary diseases. The harder and the larger and the more sharp angled the particles of dust the greater will be the damage created. As a consequence stone dust from marble cutting is much more harmful than the grain dust of rolling mills, as is the steel and stone dust from the emery wheels more productive of phthisis than is coal dust. Coarse-grained dust is more damaging than fine dust of the same substance; an exposed emery wheel will cause more breakdowns among the workmen than will a buffing wheel. Metal dust is more harmful than stone dust, and stone dust more harmful than vegetable or animal dust. Animal dust, from working with hides or grinding bone, is much coarser than vegetable dusts, and for that reason is more apt to create damage to those who inhale it. The more dangerous the kind of dust, as previously classified, the more necessary is its suppression. Certain dusts which are produced are forcibly ejected in large quantities into the face of the workman, as those produced by grinding, sharpening, polishing and buffing upon wheels. These dusts especially expose the workman and demand removal.

The principal dangerous metallic dusts are those of iron and steel, brass, lead, copper and tin. The dangerous mineral dusts include marble, granite, silica (in sand blasting), lime, cement, glass and alkali earths. The animal dusts which are most noteworthy as creating occupational diseases are bone, shell, horn and leather dusts.

Exhaust hoods, exhaust ventilation and wet processes remove or suppress dusts. Hoods without exhaust fans

retain but the largest particles, only those too large to be inhaled by the workman. All hoods, therefore, which are intended for carrying away dusts should be connected with exhaust fans which expel the dust into a water spray or into a large room or box for collecting the settled dust. The machinery which should be equipped with exhaust dust



EXHAUST HOODS PREVENT DUST GETTING INTO THE LUNGS OF THE WORKMAN

hoods include grindstones and emery wheels, burnishing and buffing wheels, paper cutting machines, lathes used for cutting pearl and bone buttons, shoe finishers, cutting and polishing wheels, horn and celluloid cutting machines. Exhaust hoods should be used where dangerous fumes are produced. These places are many but can be readily determined by the inspector. They include chemical laboratories, type foundries, melting pots of type, lead and solder, kitchen ranges, varnishing and enameling vats, acid vats and various other dipping reservoirs.

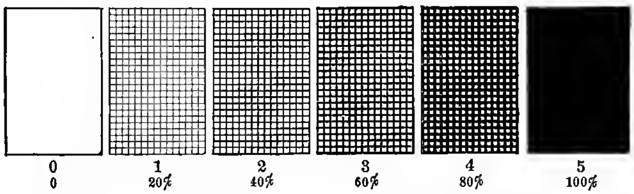
Wet processes decrease the formation of dangerous dusts. The wet process is the method of directing a stream of water on to the surface from which the dust would arise. Most glass cutting and grinding is done wet, all of it should be. In cutting, dressing and surfacing marble and building stone much dangerous dust arises from the dry stone. A stream of water directed against the surface would prevent the dust and save the workman's life. In many such cases wet grinding or cutting can be done, as in cutting pearl and bone buttons.

Respirators should be worn by the workmen where wet processes are not applicable and where exhaust hoods are inefficient.

Smoke Abatement. — The nuisance and dangers from smoke being emitted in large and wasteful quantities in cities will be abated by improvements in furnace and boiler construction. The escape of coal smoke indicates improper firing, incomplete combustion and wasted energy. The smoke created by soft coal is much more damaging than that from hard coal. Factories, large hotels and other establishments and locomotives should adopt mechanical stokers which supply the coal to the fire as it is needed and where needed, which keep the fire bed in motion and automatically discharge the ashes. Small establishments, apartment houses and residences should adopt such other forms of furnaces and boilers which will prevent the escape of smoke, as is accomplished by the down-draft boilers. Fire boxes should be designed to consume the combustible parts of smoke and to prevent the soot escaping up the chimney.

The measurement of the amount of smoke or its degree of blackness given off by a chimney or stack is not practical as the smoke varies with the time of stoking and its color decreases with the distance from the chimney and with the admixture of steam or wood smoke. An inspection of the boiler, the kind of coal used and the frequency and method

of stoking will give more information than a few minutes' view of a chimney. The Ringlemann smoke chart is the test usually used to determine the percentage of blackness of smoke, the comparison being made when holding the chart at a distance sufficient to give evenness of tone to the squares.



THE SCALE FOR GRADING THE DENSITY OF SMOKE

LIGHTING

Natural light is purer, more diffusible, cheaper and more satisfactory as an illuminant than is any artificial light. Hence it should be adopted, used and assisted wherever possible in preference to artificial illumination. Light is beneficial as sunshine is health-giving. They should both be admitted in maximum quantities into every home, every workroom, into every room occupied by people, except, of course, where the work or the usage of the room forbids the entrance of light. The natural lighting of a room may be increased or assisted by the proper color of the walls and by the proper treatment of the windows.

Rooms, no matter what their usage, should be papered or painted with the intention of increasing the lighting. Painted walls are preferable to papered surfaces in that they catch less dust, are more readily cleaned, reflect more light and the colors are more durable. Painted walls are colder in winter and tend to exaggerate plastering defects. The color of the walls very markedly affects the lighting of the room. A white wall will[1] reflect 92 per cent of the

[1] M. Gstettner: *Trans. Internat. Congress School Hygiene, Vol. V*, 1913.

light, a green wall 48 per cent, yellow 40 per cent, clear blue 30 per cent. The walls should be as light as possible, the ceiling to the picture strip being white with but a very faint tinting of yellow, green or buff color. Window roller-shades if used for checking sunlight are better if translucent, to admit light. If colored and opaque, the inner side should be white or tinted for reflecting the artificial light within. Draperies and heavy curtains are to be avoided since they retain dust and exclude light. That room will be purest which has the least window covering. The window glass should be kept clean.

Prismatic glass in windows markedly increases the lighting of the room and is especially desirable for windows opposite and near tall buildings. The prismatic glass which projects the light rays horizontally adds a great glare which is annoying and harmful to anyone facing it. The angle of the prisms should be such that the light rays are not projected horizontally but upward to be reflected by a white ceiling, especially if sunlight falls upon the glass.

Ribbed window glass slightly increases the natural lighting of a room but the glass must be washed daily to be kept perfectly clean. When dusty the glass becomes quite opaque. The irregularly ribbed glass used in windows and doors has little to commend it. If translucency is preferable to transparency ground-glass is more satisfactory.

Artificial lighting is by direct, indirect or semi-indirect means. The direct lighting is that given by bare lamps, by lamps surmounted with reflectors or by exposed lamps producing light diffused by opalescent or reflecting globes. In indirect lighting the lights are hidden behind reflectors or opaque baskets, the light being directed to the walls or ceiling to be thence reflected as a diffuse soft light. The semi-indirect lights reflect to the ceiling but also give diffuse light through the opalescent baskets or guards which serve as reflectors. These last are the best. The more soft and diffuse the light the better, and also the more expensive.

The ideal lighting gives an evenness of illumination, a diffuseness without glare and a light nearly white. A white light is better than a yellow or blue light.

The light should shine upon the work, not into the eyes of the workman. The light should be located and arranged with shields or reflectors for the purpose of effective lighting and not for economical or artistic purpose. The light should be shielded from the eyes. When the direct lighting is done by electric globes they are better if placed horizontally with a reflector above, for downward lighting, as the intensity of light from electric globes is many times greater at right angles to the side than axially from the tip. The advantages of tungsten lamps over the old carbon lamps are manifold. Ogley has shown that the candlepower of tungsten lamps remains practically constant after more than a thousand hours of use, but that of the carbon lamps very rapidly decreases.

Acetylene gas is a very satisfactory illuminant for country houses.

VENTILATION

The needs of ventilation are very variable and the methods adopted depend upon the particular conditions to be met. Under some conditions the natural air flowage will suffice, but usually some artificial propulsion is necessary. In certain rooms or buildings a circulation of the air is sufficient, but under other conditions a complete renewal of the air is imperative. While designing or operating a ventilation system consideration is given to the cubic capacity per capita, the age of the people supplied, their general cleanliness, to their social standing, racial characteristics and desires, and to their occupation within the room.

The more desirable air for a room, as has been shown by recent investigations of the New York Ventilation Commission, is that which is not too hot, not too dry nor too damp, and that which is kept in motion. Hot, humid,

stagnant air is to be avoided. Air movement rather than air change is usually the desirable condition. The effect caused by vitiated air is cutaneous rather than respiratory. The chemical quality of a room air is of little or no importance if the air be kept cool and in motion. Odors are objectionable from the esthetic standpoint only. Any bacteria in the air are of little consequence in this consideration. Dust varies considerably in amount and may be quite objectionable. It is now known that the amounts of oxygen and carbon dioxide as found in rooms have no practical bearing on the problems of ventilation except in special rare instances. Ordinary air contains about 21 per cent of oxygen and yet the air of badly ventilated rooms will rarely, if ever, fall below 19 per cent in oxygen. The carbon dioxide content in the most stuffy, unventilated room rarely reaches an increase of even so little as 0.1 per cent (Winslow). The oxygen and carbon dioxide content theories of vitiated air are, therefore, untenable and any tests to determine their proportions are of little value for indicating the desirability of a room air. Since for legal enforcement numerical standards are frequently essential the importance of determining what constitutes vitiated air and how it may be tested is evident. The impurity of impure air is yet unknown. Until specifically determined, the legal standard for pure or satisfactory air may be based upon temperature, humidity, odors, dust and stagnation.

The object in ventilation is to introduce pure air. Practically it makes no difference whence the pure air comes. If the air admitted through open windows is more desirable in quality than that which comes up the air ducts the windows should be opened. If the cold air coming in the open windows forces the foul air through doorways into other rooms, the doors should be closed. If the artificial supply is yielding air too hot or not of the proper humidity, opening the windows temporarily will give the desired air or will cause a sudden changing of the entire supply. Good

ventilating systems are not unbalanced by opening windows. If the system is properly designed the regular air flow will begin as soon as the windows are closed again. It is very frequently desirable to quickly change the air of a room, as of a schoolroom during recess, and this can best be done by opening the windows. This may not be necessary if the room temperature and air movement are right.

In window ventilation the fresh air goes into the room only by the force of the winds or by a difference in temperatures. When the outside air is much colder than the room temperature, upon raising the lower sash the air rolls in towards the floor, circulates through the room and escapes through the doors and opposite windows, or else it escapes out the upper part of the same open window or between the sash. Fresh air cannot be admitted unless the inside air escapes to give it room. If a room is ventilated by a single open window, deflectors should not be used to give the incoming air an upward course, as a downward air current in front of the window is desirable to permit the upper warm foul air an opportunity to escape out the upper part of the same opening in the window. If the warm foul air may escape out an opposite window on the lee side, out a doorway or up a chimney, window deflectors are useful in preventing floor drafts and in circulating the stagnant ceiling air. A deflector is a piece of plate glass or board about nine or twelve inches wide and extending the width of the window, and placed nearly vertically two or three inches inside the window at an angle leaning inwardly. Where the natural ventilation is due to winds alone — that is, where there is practically no difference between external and internal temperatures — it is necessary to provide air exits by windows, doors or open chimneys. When stoves are removed from rooms for the summer the stove-pipe openings in the chimneys should not be closed up, but be left open for ventilation and only covered over by mosquito netting to exclude insects.

Artificial Ventilation. — Artificial ventilation is a method to augment the natural flow of air or to compel an air change when the natural forces are quiescent. A complete ventilating plant comprises both active and passive agencies to force fresh air into a room while drawing the foul air out. It employs air blowers and exhaust fans. These two sets of fans should usually have the same capacity, but all the identical air which is forced in by the blower will not pass through the exhaust fan, there being much leaking at the doors and windows.

In artificial ventilation the direction of flow of the supplied fresh air and the positions of the ventilators and exhaust vents depend upon the size and shape of the room and the number of people to be supplied. In small rooms, accommodating but a few people, the air is best supplied through ventilators about six feet above the floor and exhausted through vents at the floor level and upon the same wall as the ventilators. In workrooms where the carrying away of dusts and noxious gases is to be provided for, the vents should be placed where these dusts and gases are made and where they collect.

In larger rooms, meant to accommodate many people, the fresh air should be so supplied and distributed that in all parts of the room there is a perceptible current of air. In most cases this current should be perceptible to the moist hand, in all to the smoke-test (a blowing of smoke into the room and noting a distinct and rapid drift toward the air exits). Joss-sticks are useful for testing air-flow. Foul air as it is exhaled from the body probably rises.

A personal inspection and investigation of the ventilation methods of one hundred and thirty-seven moving picture theaters during exhibitions to full houses in Chicago has convinced the writer to hold certain opinions regarding desirable and efficient ventilation systems. For this purpose moving picture houses should be classed as large or as one-lot houses. The one-lot house is long and narrow,

occupying but a single house lot, and seats approximately three hundred persons. These small theaters require a differently designed ventilation system from the large theaters. The schemes for ventilating the larger houses may be designed the same as for large play houses since they are built with high ceilings; the system used not necessarily depending upon the presence or absence of balconies, the same system is applicable for all broad and high-ceiling theaters and auditoriums. The small amusement houses, built upon a single house lot, deep and narrow with a low ceiling, are best ventilated by side-wall air supply. The fresh-air inlets should be distributed along the side walls about seven or eight feet above the floor; the foul air is allowed to escape at the end doors, or by floor or ceiling flues, preferably the last. The side-wall supply of fresh air, as was demonstrated by the Chicago inspections, gives much better air conditions than can be obtained by air being admitted at the ceiling and removed from the floor level, or by the reverse flow, or by a single large supply being given at the stage end with exhaust through the front doors. Exhaust fans used alone in lieu of supply blowers should not be tolerated in small crowded amusement halls. In larger auditoriums the fresh air should be supplied in such quantities that there is a distinct air movement in every part of the house, and yet if the supply is admitted through the floor the openings should be sufficiently numerous to prevent floor drafts.

Small crowded stores and workrooms should be ventilated by the same method, with an effective blower distributing the fresh air from duct openings along the side walls, or so situated that there will be an even distribution of air with the formation of perceptible currents. The air intake should preferably be at the rear end of the roof but as far as possible from all chimneys, dusty streets, kitchen windows and other localities where dust, gases, odors or smoke might be admitted into the intake.

Where it is not desirable to install both fresh air blowers and exhaust fans, where only a single propeller is wanted, it is usually advantageous to use the blower in preference to the exhaust fan. The use of the blower in forcing fresh air into a room or building creates a slight increased air pressure within the room. This is the plenum system simplified and allows the vitiated air to escape by the doorways or windows. When air is forced in through ducts it is collected where most pure and desirable, from near the roof or high above a street or from a better locality, and is distributed where needed. The exhaust system, when not accompanied with fresh air blowers and intake, simply removes the air without providing the best obtainable air to be taken in. The in-going air leaks in through the doorways and carries in the dust of the street or smoke from near-by chimneys. Exhaust fans should be used alone only when there is some special reason for not permitting the removed air to escape upon the street or into other parts of the same building. If a complete ventilation system is not provided exhaust fans should be used for such places as chemical laboratories, foundries, smelting rooms, forge rooms, hotel kitchens and for other places in which dangerous fumes, noxious odors and dust are made, and where these by-products are to be controlled and not allowed to collect or to be dispersed to other parts of the building or vicinity. Exhaust fans are not adaptable for use in stores, offices, theaters, assembly rooms, churches, club rooms, restaurants and residences except in conjunction with fresh air blowers. The usefulness and need of exhaust fans to remove industrial dusts and fumes is considered under factory hygiene.

Recirculation of the air in residences, schools or factories may be desirable. The exhaust air is carried off, washed, adjusted to the desired temperature and humidity, and forced back into the rooms. Sufficient new air is introduced to replace that which is lost through doorways and

windows. Recirculated air, when properly treated, is satisfactory and prevents waste of heat, reducing the heating cost about one-half. Recirculation is especially adapted to churches, large factories and stores which contain few people and do not generate noxious or dangerous gases, to libraries, to some theaters, offices and schools in which there are not many people. Where a recirculating apparatus is installed arrangements should be made for the recirculation to be stopped at definite intervals and outside fresh air introduced.

Air flow is measured by the anemometer which measures the rate of flow. The measurements should be made at the mouth of the intake or within the intake supply duct, and not at the exhaust flue. The anemometer reading for one minute multiplied by the area of the intake duct in square feet gives the cubic feet of air supplied per minute. The measured capacity of the room and the known air supplied will give the number of air changes per hour.

Washed air is air which is propelled by blowers and passed through a spray of water. Air washers are attached to the most complete ventilating systems. The falling drops of water remove from the air dust particles, most odors and gases; they supply the needed moisture and help to regulate the temperature of the air. The air is washed before it passes through the heating coils. Unless the unwashed air is very free from gases, odors and smoke, the water should be used but once. In recirculated air the wash water should be used only once, thence being discharged into the sewer.

HEATING

The heating of buildings is done by the direct, the indirect or the direct-indirect systems. In the direct system the heating apparatus, stove or hot radiator, is situated within the room heated; the direct system provides for no ventilation. The indirect method is that in which the

heating apparatus is outside the room, the heat being brought in by heated air introduced through ducts. The direct-indirect combination is a hot water or steam coil within the room and provided with a duct admitting fresh air directly from outdoors to the coil. Each system has its advantages and disadvantages which should be considered before making the selection for installation.

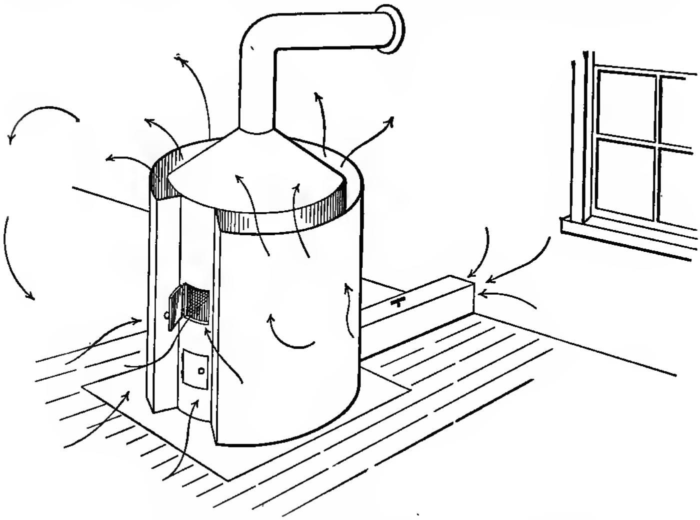
The most desirable temperature for rooms is between 68° and 72° F. In rooms in which heavy physical work is done it is better to maintain a temperature between 50° and 60° with a low relative humidity, 35 to 40 per cent.

Direct Heating. — In the direct heating system the heat is supplied from a fire within the room or from a coil radiator. The heating of the room takes place to a slight extent by direct radiation but principally through convection. In convection the air near the heat generator becomes warmed, expands and rises, forcing the cool air of the room toward the stove to be warmed and to rise and continue the circulation of the air. This provides for air motion but not for much or any replenishing by fresh air.

A stove in a room may be made to serve not only as a heater but as an efficient ventilating apparatus by enclosing it in a tall jacket open only at the top and connecting at the bottom with an air-duct leading out of doors to admit fresh air. The air duct should be equipped with a damper. This heating-ventilating system, as illustrated, is especially adaptable for use in small rural schools, stores and houses. The jacket may be designed after the pattern herewith shown. The front ends of the jacket should form a tight joint with the stove, preferably with asbestos packing, to insure all the warm fresh air circulating throughout the room. The vitiated air is exhausted from the room by its going into the fire.

Stoves are efficient heaters if not of faulty design nor improperly placed. Carbon monoxide and other poisonous gases of combustion are given off within the stoves. Under

proper attention these will all pass up the chimney, but there must be a constant draft toward the flue. When the draft is taken off by opening the door of a stove or by removing the lids of a kitchen range the opening should not be so large that there is not a draft inward toward the chimney. A match flame should be drawn inwards toward the fire, else there will be an escape of coal-gas into the room.



A VENTILATING STOVE FOR SCHOOLS AND STORES

Open fires and grates are very inefficient from the standpoint of heating, since the greater amount of heat generated passes up the chimney. Open wood fires are picturesque and pleasing, but should be properly designed to produce heat and not smoke and gases for the room. If a room is heated by an open fireplace and fresh air is admitted through the windows the window sills should be equipped with air deflectors to give the incoming air an upward current. This will provide a more even circulation and will prevent cold floor drafts.

Open fire grates, as used in the southern states, are an

abomination, being very inefficient. When coal is burned in the open grates the yield is much soot or dust, a large amount of poisonous gases and practically no heat. Where gas grates or gas-logs are installed in a house they should always be provided with chimneys which actually open above the roof. Movable gas grates and coal-oil burners are dangerous and should be condemned since they emit dangerous gases of combustion, and the air warmed by them becomes vitiated, dry and too hot. With the gas burners there is danger from leaking gas, and from the oil burners danger from fire by explosion or leaking oil tank. Portable gas stoves, gas heaters and gas table lamps are frequently connected up with cheap or old rubber tubing which leaks gas. To minimize the danger of accidental asphyxiation these burners should not be provided with cocks, to insure that the gas will be turned off at the iron gas pipe and the rubber tubing not left filled with gas under pressure.

A steam heating system is usually to be preferred to the hot-water radiator heating system, but has certain disadvantages. The heat from a steam system is more quickly obtained than with a water system, since there is less water to heat. If the building is part of a solid row, offering less radiation and leakage of heat, the steam is preferable, requiring less coal. The steam radiators add to the air the moisture so necessary and essential to comfort, the air valves constantly permitting a small amount of steam to escape. It is easy to control the heat generated by a steam system to meet outside weather conditions, since the radiators will heat or cool rapidly at will. In very cold climates the steam is preferable to the hot water system since it will produce much greater heat. A steam system may be constructed with a single pipe system, but a hot-water system requires a return pipe. If the single piping be used with the steam system all branches and horizontal piping should be laid with considerable slant to provide good drainage

for all water from condensed steam, for where water is allowed to collect the noisy hammering will result. The steam system requires much more attention than the hot-water system, both at the fires and at the radiators. As the fires cool down the steam radiators cool rapidly, the resulting heating not being uniform. When the radiators are turned off at the valve to cool, the steam within the coils condenses. It is then necessary in the evening to turn on the valve to permit this water to drain into the boiler, for if it is left within the coil until steam pressure is again up water-hammer results and the water may be ejected at the air-valve. This does not occur with the two-pipe system. The air valves of the steam coils may be faulty and not work properly.

The hot-water system is slower to heat and slower to cool than the steam coils, is more uniform, produces less heat, requires less attention, produces less nuisance, and requires more piping and a larger heating plant than the steam system. It does not affect the humidity in the rooms but offers a supply of hot water for use for other purposes. Larger coils of more stacks are required than with steam. The water coils retain their heat longer than the steam, hence do not cool down so quickly after the fires are banked at night, and unless the weather is very cold or the windows not tight, the water coils may keep the rooms warm all night. Great care is needed that a house is not left with pipes or coils filled with water which might freeze and burst the pipes, an accident not apt to occur with a steam system.

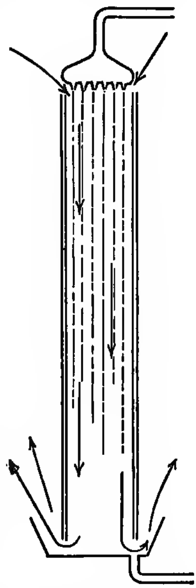
Greater heat will be obtained from the hot water coils if they are painted with gilt or aluminum paints. Colors which reflect well absorb poorly and hence radiate well. Stoves, steam pipes used for heating, and heating coils should be painted white. Refrigerators and walls of rooms should be painted white or light colors, since a refrigerator painted white outside will remain colder, and white walls will reflect more heat and light than would dark ones.

Summarizing the advantages: the choice may be given the steam heating system for very cold climates; for houses not especially exposed to strong winds, houses of a solid row; where a heating of the rooms is desired upon short notice; for apartments, residences and factories rather than for schools and auditoriums; where the house is apt frequently to be left to become cold, permitting freezing; and where frequent attention may be given the fire. The hot-water system is, therefore, applicable in climates not extremely cold; in damp regions; for schools or other buildings where many people are working; where uniformity is required; in separated, exposed buildings; and where there is little outward leakage of warm air.

Indirect System. — In the indirect heating system the heating apparatus is usually situated entirely within the basement of the building, the hot air being distributed to the various rooms through a system of ducts. With the indirect system ventilation is supplied. The hot-air cellar furnace belongs to the indirect system, as does the method of heating which is combined with artificial ventilation by blowing fresh air over hot coils before being forced into the rooms. The air which is supplied the indirect system should always come from outdoors, except where the room air is exhausted, washed and recirculated. Damp cellar air, smelling of mold, plaster or offensive gases or containing ashes and coal dust, should not be admitted to the heating apparatus to be supplied to any room. The air should be admitted through ducts which derive their supply from that locality and level which will carry with the incoming air the least amount of dust, dampness, gases, smoke and coal-gas.

Direct-indirect System. — In rooms equipped with the direct-indirect heating system a steam or hot-water coil is located next to an outside wall. At the base of the coil is a short duct leading through the wall to admit the outside air. The fresh air is blown in or is drawn in by gravity,

and passing up through the coil becomes heated and rises. The outer end of the wall duct is covered with a grate to check winds and to exclude birds. The inside end is provided with a valve opening. The objections to this faulty system include the dangers of dust, smoke and odors being admitted through the ducts, and the influence of strong winds upon the uniformity of the heating. High winds will force into the ducts a lot of cold air, chilling the rooms on the windward side of the building, the side which always needs the greater amount of heat. The rooms on the lee side are therefore warmer and less dusty. A system of ducts, enclosed by brick or terra-cotta, designed to carry air from the roof to the various wall inlets, would overcome the effect of the winds and exclude street dust. The ordinary distribution of air inlets dotting the walls of a building equipped with this system is an architectural disfigurement, but the gratings may be inserted deeply and hidden. The direct-indirect system is too faulty and is not recommended.



AIR COOLER AND HUMIDIFIER OPERATED BY A SPRAY OF FALLING WATER

Air Cooling. — The air of a room or building may be cooled by a refrigerator system, by air-washers attached to the mechanical ventilation plants, or by the use of a water spray or fountain within the room. A cooled air is also obtained by using much marble in the exposed structure of a room or corridor. The evaporation of cold water by sprinkling or by hanging up wet sheets will cool a room. For a small room a very efficient method for cooling the air is by using a shower spray the rain of which falls down through a long vertical metal duct. A sprinkler, similar to the overhead shower of a

shower bath, is arranged to spray the fine streams of water at full pressure down through a duct which is but slightly larger in diameter than the spray. The duct is fully open at the lower end to allow a free circulation of air to pass down the tube with the water. The water falls into a drain below. The full force of the falling water causes a strong draft of air down the tube, rapidly circulating and cooling the air of the room. All these water sprays require much water and produce a high degree of humidity.

Humidity. — Humidity is the amount of water in the air. When this amount is expressed in terms of the tension exerted by this vapor it is designated the absolute humidity. The humidity is usually considered as the percentage which the amount of vapor present bears to the maximum amount of water which air of the same temperature and pressure can hold. This ratio of the existing quantity to the amount which would saturate is termed relative humidity.

Working in an atmosphere too dry or too moist produces serious physical results. One condition causes too rapid evaporation from the body and the other prevents the normal radiation of heat and moisture. Rubner found that a temperature of 75° F. with a relative humidity of 80 per cent causes heat retention, and Huldane determined that moderate work at a wet bulb temperature in excess of 78° F. was impractical because of heat retention. For comfort, the relative humidity should be between 45 and 70. Certain occupations require a high degree of humidity in the factories, and in certain others, as in lithography and silk manufacture, there should be maintained a constant humidity which does not vary with the weather. For most places when the temperature is at the desirable degree, between 60° and 70° F., a relative humidity of about 50 per cent is very comfortable. With higher temperatures the humidity may be slightly greater. During the winter months the humidity of rooms should be low.

The humidity of a room or factory may be decreased by installing a refrigeration system or by recirculating the air over a system of pipes kept cold by cold water or brine, the piping condensing the moisture. The humidity may be increased by blowing steam into a room, by evaporating water over a stove or hot radiator, or by supplying fresh air which has been forced through air-washers. In artificial humidification the dangers of spraying odors, chemical substances and bacteria into the air to be inhaled should be guarded against by using only pure water or clean steam. Exhaust steam is apt to be oily and should not be used. Any foreign substance sprayed or evaporated into the air becomes an objectionable impurity. Floors should not be sprinkled as a means of increasing humidity as the dampness of them may be injurious to the workmen. Suspended wet sheets or curtains are safer.

Relative humidity is determined by a comparison of the temperatures as shown by the dry and the wet bulb thermometers. The less the amount of moisture in the air of a room, or the greater the degree of dryness, the more rapid will be the evaporation of water from the wet bulb thermometer, and the lower the temperature will be recorded. Humidity is tested by the revolving psychrometer. The old style hygrometer with two thermometers on a board to hang stationary upon a wall does not show the actual conditions and is very misleading. The psychrometer is constructed of two thermometers, one wet bulb and the other dry, which can be revolved very rapidly. The psychrometer used by the Weather Bureau is the most accurate and consists of a metal base with thermometers which are revolved at a high speed by multiplying cogwheels. The sling psychrometer is used for general work and, according to McCurdy, is accurate within two per cent for ordinary temperatures. In establishments where a constant humidity must be maintained, recording psychrometers should be installed.

DRY TEMPERATURES	DIFFERENCE BETWEEN THE DRY AND WET THERMOMETERS																																				DRY TEMPERATURES
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
30	100	89	78	67	57	47	36	26	17	7																												30
35	100	91	82	73	65	54	45	37	28	19	12	3																										35
40	100	92	84	76	68	60	53	45	38	30	22	16	8	1																								40
45	100	92	86	78	71	64	58	51	44	38	32	25	19	13	7	1																						45
50	100	93	87	80	74	67	61	55	50	44	38	33	27	22	16	11	6	1																				50
55	100	94	88	82	76	70	65	59	54	49	43	39	34	29	24	19	16	10	6	1																		55
60	100	94	89	84	78	73	68	63	58	53	48	44	39	34	30	26	22	18	14	10	6	2																60
65	100	95	90	85	80	75	70	65	61	56	52	48	44	39	35	31	28	24	20	17	13	10	8	3														65
70	100	96	90	86	81	77	72	68	64	60	55	52	48	44	40	36	33	29	26	23	19	16	13	10	7	4	1											70
75	100	95	91	87	82	78	74	70	65	62	58	55	51	47	44	40	37	34	31	27	24	21	19	16	13	10	7	5	2									75
80	100	96	92	87	83	79	76	72	68	64	61	57	54	51	47	44	41	38	35	32	29	26	23	20	18	15	13	10	8	6	3	1						80
85	100	96	92	88	84	80	77	73	70	66	63	60	56	53	50	47	44	41	38	36	33	30	28	25	22	20	17	15	13	11	9	6	4	2				85
90	100	96	92	88	85	81	78	75	71	68	65	62	59	56	53	50	47	44	41	39	36	34	32	29	26	24	22	20	17	15	13	11	9	7	6	3	2	90
95	100	96	93	89	86	82	79	76	72	69	66	63	60	58	55	52	49	47	44	42	39	37	35	32	30	28	26	23	21	19	17	15	13	11	10	8	6	95
100	100	97	93	90	86	83	80	77	74	71	68	65	62	59	57	54	51	49	47	44	42	39	37	35	33	31	29	27	25	23	21	19	17	15	14	12	10	100
105	100	97	93	90	87	84	81	78	75	72	69	66	64	61	58	56	53	51	49	46	44	42	40	38	35	33	31	30	28	26	24	22	20	19	17	15	14	105
110	100	97	94	90	87	84	81	78	76	73	70	67	65	62	60	57	55	53	50	48	46	44	42	40	38	36	34	32	30	28	27	25	23	22	20	19	17	110
115	100	97	94	91	88	85	82	79	76	74	71	69	66	64	61	59	57	54	52	50	48	46	44	42	40	38	36	34	33	31	29	28	26	24	23	21	20	115
120	100	97	94	91	88	85	83	80	77	75	72	70	67	65	62	60	58	56	54	51	49	47	45	44	42	40	38	36	35	33	31	30	28	27	25	24	22	120
125	100	97	94	91	88	86	83	80	78	75	73	70	68	66	64	62	59	57	55	53	51	49	47	45	43	42	40	38	37	35	33	32	30	29	27	26	24	125
130	100	97	94	91	89	86	83	81	78	76	74	71	69	67	65	62	60	58	56	54	52	50	49	47	45	43	42	40	38	37	35	33	32	31	29	28	27	130
135	100	97	94	92	89	86	84	81	79	77	74	72	70	68	65	63	61	59	57	55	53	51	50	48	46	45	43	41	40	38	37	35	34	32	31	30	28	135
140	100	97	95	92	89	87	84	82	79	77	76	73	71	68	66	64	62	60	58	56	55	53	51	49	48	46	44	43	41	40	38	37	35	34	33	31	30	140
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	

SCALE OF RELATIVE HUMIDITY

Relative humidity is calculated by Apjohn's formula:

$$\text{Humidity} = \text{wet bulb} - 0.01147\,(\text{dry} - \text{wet bulbs}) \times \frac{\text{barometer in millimeters} - \text{wet bulb-reading}}{30}.$$

The standard tables furnished by the United States Weather Bureau (U. S. Dept. Agric. W. B. Bul. No. 235) may be used to determine the relative humidity. The actual dry bulb reading and the difference between the dry and the wet bulb readings are compared with the standard table. A dry bulb reading of 75° with a wet bulb temperature of 68° would give a relative humidity of 70. A dry temperature of 77° with a wet bulb temperature of 68° would give a relative humidity calculated to be 70.8.

CHAPTER XI

THE DESTRUCTION OF INSECTS WHICH TRANSMIT DISEASE

The rôle which insects play in the transmission of disease is recognized as of the greatest importance. The progress of research and animal experimentation, reflecting new light upon the causation of disease, constantly reveals the necessity of a study of the habits of insects and the need of effective means to prevent the insect transmission of disease. Some insects serve as hosts for the disease organism which must go through some cycle of development outside the body of man; as, the malaria mosquito. Some insects infect man by the accidental injection of bacteria through their bite after themselves becoming infected by previously biting an infected person; witness the transmission of bubonic plague by the flea. Other insects are merely accidental carriers of germs, depositing these pathogenic bacteria from their contaminated feet or their dejecta, as occurs with the typhoid house fly.

The practical consideration of public hygiene does not herewith invite a discussion of the theories of insect transmission of disease. Authorities have proved that malaria and yellow fever and bubonic plague and typhus fever and a few tropical diseases can be transmitted in no other way. Practical sanitation is not a determination of the biological characteristics of species but is the adoption of practical measures which will detect and destroy the dangerous insects.

Sanitation requires that all the breeding places of the insects be discovered, their habits of eating and travel be learned, and that practical means for their destruction be

devised. In the destruction of insects supplementary use is made of their natural enemies. It is important to know which insects are dangerous and where they abound. Their breeding places are found and subjected to such measures as are locally applicable. It is important to know how far the disease-transmitting insects can travel. The probable direction and distance of travel of suspected insects is a point for epidemiological investigation in the search for the source of an outbreak. By the study of the flying distance and the direction of the prevailing winds, distant localities hitherto unsuspected may be found to have had earlier cases of the disease and to furnish a plentiful supply of the insects which may and probably did carry the infection. If a source of infection cannot be found locally a study of the travel of insects may reveal that beyond some body of water these insects are very abundant and a further search may bring to light some unsuspected cases of the disease.

In mosquito-ridden localities the native inhabitants become so immune to mosquito bites that their opinion of the existence of mosquitoes cannot always be accepted. If malaria is suspected as being present a mosquito survey will assist to verify the suspicions. When malaria appears in a locality an anopheles survey will help to establish the district over which the malaria may spread and will indicate the most practical and economical measures to adopt, and where they are needed.

MOSQUITOES

Of numerous insects concerned in the transmission of disease, mosquitoes are the most important. All mosquitoes are pests and their universal destruction becomes a duty. Certain mosquitoes transmit specific disease and their destruction is of the utmost importance for the protection of man and industry. In anti-mosquito work the mosquitoes against which the war is waged are classed as a public nuisance or a public danger. That the work may

be carried on practically and successfully it is important to understand where mosquitoes breed, their habits, their enemies, and how approximately to identify the generic types of the disease carriers. In temperate regions the malaria mosquito is the one important member of the order. Since anti-malaria work is dependent upon activity in sanitation rather than in entomological research it is sufficient to consider mosquitoes simply according to the genera — *Anopheles*, *Stegomyia* (*Aedes*) and *Culex*. For the purpose of simplicity, all the native American species which do not serve as hosts for malaria or yellow fever organisms may be included by the common title *Culex*, although many do not belong in that genus.

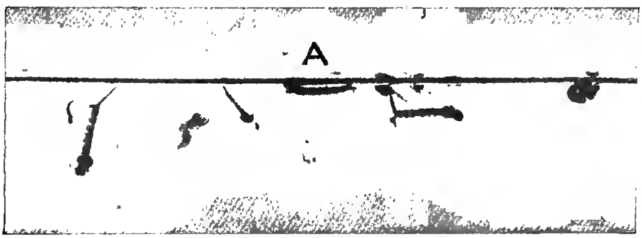
The malaria-bearing mosquitoes belong to the subfamily *Anophelinæ* and are recently classed under one genus, *Anopheles*. Of the many determined species forty are more or less definitely known to transmit malaria. Frederick Knab has listed thirty-four American *Anopheles* of which eight have definitely been shown to harbor mosquito parasites. These are:

Anopheles albimanus	*Anopheles quadrimaculatus*
" *argyritaris*	" *pseudomaculipes*
" *crucians*	" *pseudopunctipennis*
" *intermedium*	" *tarsimaculata*

The elimination of malaria from a community depends very largely upon the complete destruction of the breeding places of the *Anopheles* mosquitoes. These individual bodies of water harboring the *Anopheles* must therefore be discovered. Any water found containing wrigglers or mosquito larvæ is treated to destroy them. But it is important to know if a certain pool is responsible for the malaria mosquitoes.

The practical identification of the mosquito young is made by the investigator noting marked generic characteristics in the ova, the larvæ or in the pupæ. The egg

collections of *Culex* appear as brownish masses, like soot, lightly floating over the surface. They are about an eighth of an inch long, not quite so broad, concave upon the upper surface and composed of about seventy-five to two hundred erect ova. They are readily crushed, showing the minute ova separately. *Anopheles* ova float individually and are about the same size as *Culex* but lie flat upon the surface. They may float singly or in such collections as matches will assume floating on the surface. The larvæ, called wrigglers or wiggle-tails, of *Culex* float in the water with the body at an angle of about forty-five degrees with the surface. The breathing



MOSQUITO LARVÆ
A, *Anopheles;* others, *Culex*

tube at the posterior end of the body is very pronounced, and may be seen projecting above the surface. The *Anopheles* larvæ have very short or inconspicuous breathing tubes and while resting just beneath the surface the *Anopheles* larvæ float with the body parallel with the surface. The pupæ of the genera are less easily differentiated. The *Culex* pupa floats beneath the surface more erect than does the *Anopheles*, the long axis of the head section being vertical in the *Culex*, but in the *Anopheles* at nearly a forty-five-degree angle. The adult mosquitoes are readily distinguished by the position assumed while resting. The *Culex* mosquito rests with the body close to and parallel with the surface upon which it stands. The

Anopheles rests with the body poised at an acute angle as though preparing to strike. The body is held at an angle between forty-five and eighty degrees to the surface and the hind legs may be raised high in the air. Other differential characteristics of the adults include differences in the antennæ, and spots on the wings of *Anopheles*.

The female mosquito is the only one which bites, and she has her greatest activity during the period of flight at dusk. Mosquitoes begin to fly about sundown and stop soon after dark. During the day they keep protected from the light and wind.

Mosquito Surveys. — In a malarious territory a careful survey will discover the particular haunts of the mosquitoes and will indicate how much work needs to be done to stamp out the breeding places. The surveys[1] are made to determine the location and extent of the anopheline breeding places, a determination of the species, their habits of flight and the distance traveled. The topography and character of the country covered is noted, together with what practical improvement is required at each place found harboring mosquitoes. The asset of land improvement and the adaptation of this land to agricultural or industrial purposes are noted as further benefits to be derived from the antimalarial measures to be adopted. When advising the adoption of antimalarial or anti-mosquito measures consideration should be given the practical results to be gained in increasing the health and comfort of the community, in increasing realty values and making land more habitable, and in enhancing the adaptation of the territory to agriculture, or to industrial or residential purposes.

Before beginning a survey the health officer obtains information regarding the number and location of the cases of malaria, the types of infection, the seasonal prev-

[1] "Anopheline Surveys," Dr. R. H. Von Ezdorf: *Public Health Reports*, Apr. 30, 1915.

alence, the influence of rainy season or drought, and the relative prevalence of mosquitoes in different locations as reported. The locality to be covered should be mapped. Upon the maps are spotted the localities of the cases of malaria. There is also mapped the locations of the various industrial establishments, including the source of their water supplies; the topography, the natural water courses, the direction of surface drainage, the presence of ditches, swampy land and poorly drained areas, and the direction of the prevailing winds are indicated on the map. The relative rapidity of flow of the rivers and the presence of dams and ponds are important points. Some of these data will be gathered during the survey.

With this map and information the investigator begins his walk, equipped with a glass tumbler or long handled dipper for collecting wrigglers and small bottles for preserving them. An eye-dropper or glass tube is used for transferring the larvæ from the tumblers to the bottles. A determination of the species by the larvæ is very difficult. Therefore the larvæ should be kept alive until they develop into the imago or adult state. The mosquitoes may then be sent to an entomologist for indentification.

Wherever shallow quiet collections of water are found search is made for mosquito larvæ. The tumbler or dipper is gently lowered beneath the surface, the water being allowed to pour over the edge. The water collected is examined for the presence of larvæ, pupæ and ova. Any seen may readily be caught in the dropper or glass tubing and placed in a small bottle or vial and labeled with the locality. In collecting specimens it is useless to search in an open stream of running water. The collections of water examined are legion in their character or location.

Natural bodies of water which harbor mosquito larvæ include quiet brooks, the edges of creeks where sticks or plant life prevent movement of the surface, the edges of small ponds, ditches, swamps, wet areas, especially wet

ground under leaves in a woods, pools of water along the roadside, pools upon rocks, or clay beds and wet cultivated fields. There is no danger of flowing streams producing mosquitoes except during drought or when the water is very sluggish. Wrigglers will not develop in water having ripples or where there are fish which can reach the quiet surface areas. Wrigglers may be found on top of lily-pads protected from the fish beneath. Duckweed and the stringy, green *spirogyra* assist and protect the wrigglers. The mosquito larvæ will rarely be found in dense, overgrown cattail areas. The smaller the body of water the more apt are mosquito larvæ to be found. They are most apt to be found in water which has collected accidentally, as in roof gutters, discarded bottles or tin cans. Mosquitoes will breed in the dammed up puddle in the street gutters, in a puddle beside a hydrant or fire-plug, in the open house drain, in depressions on the lawn or in urns. Around the barn they may be found in the puddle at the bottom of the roof rain-leader, in the grindstone water, in the watering trough, in the barn drainage or at the rubbish pile — in anything which retains a small amount of rain water. Within a house they may be found breeding in pitchers of unused water or in flower vases. Wash tubs and rain barrels are the favorite breeding places. In unoccupied houses they may be found breeding in the flush tank or hopper of the toilets, in bath-tub or basin traps, in any water left standing anywhere or in water collected on the cellar floor. In searching cemeteries the *Anopheles* may be found in urns, in bottles or vases, or perhaps in puddles along the aisles. Rain water barrels, water tanks, cisterns and shallow wells give excellent harbors for mosquitoes. Mosquitoes will be found breeding much more often in artificial collections of water than in natural pools or puddles — in the rain water which collects in things or appliances made by man rather than in water which collects upon the ground surface.

Bushes do not produce mosquitoes, but trees, bushes, vines, and tall grass offer mosquitoes protection from the wind. Mosquitoes fly from the pools of water towards houses and during the day seek shelter in a bush or vine. In swampy regions where it is impossible to prevent mosquitoes breeding, removing bushes and vines around the houses will decrease the mosquitoes. In malarious regions the ground should be cleared of all plants which would harbor mosquitoes within a distance of five hundred feet. If all breeding places can be found and controlled the underbrush will have no mosquitoes to protect.

When mosquito larvæ are found they should be killed immediately, if possible. The investigator should carry some oil while making the survey, and use the oil or other anti-mosquito measures immediately for small breeding places, as these places may not all be found upon the second visit. The water should be poured out of all receptacles which are then broken, turned over, filled with earth, drained or otherwise treated to prevent water collecting. Small pools are drained, stream obstructions are overcome and small stream channels may be diverted at the time the breeding places are found during the survey. Big projects are completed later.

Anopheles mosquitoes do not breed in salt water and prefer uncontaminated water, but *Culex* larvæ may be found in water containing soap, grease, oil, barnyard drainage or sewage. *Culex* eggs will hatch in old paint pots and in water containing iron rust.

The *Culex pipiens*, the common house mosquito, hibernates in the adult stage during the winter, at which time it does not bite. It prefers to sleep in the cellar, upon the ceiling or walls. This *Culex* breeds continuously during the summer; according to Smith the cycle from egg to adult requires in New Jersey about eight days and females a week old lay eggs. In midsummer an undersized brood may develop through pool congestion.

These small mosquitoes are able to penetrate ordinary screens. The appearance of undersized mosquitoes indicates that they are developing in great numbers in a very small body of water. The *pipiens* will breed in polluted water, in cesspools, manure pits, and gutters. This common mosquito with its vicious bite may therefore inject sewage or pyogenic bacteria and, therefore, is to be feared rather than only regarded as a nuisance.

The *Stegomyia calopus*, or *Aedes calopus*, the yellow fever mosquito, is a domestic insect, usually breeding in little puddles of water very close to where the adults are found.

Adult *Anopheles* mosquitoes when within houses seek dark recesses in which they may be found, as in closets, behind pictures, in dark corners, under beds, behind doors, in dark clothing, in open fireplaces and under mosquito bars. They also collect in privies, on tree trunks, in stumps, in caves, underneath overhanging banks of streams, on spider webs, under wagons and within sheds and other buildings. The *Anopheles* usually do not fly far, rarely half a mile and often not over five hundred feet. James,[1] however, after dyeing *Anopheles* mosquitoes, liberated them and caught some of them 4700 feet away. In Panama they were shown to fly a mile or more, but usually when mosquitoes travel long distances the wind has blown them. They fly during dusk, before dark, but chiefly in the early morning hours just after daybreak. People who are out early in the morning or those who may be bitten in their homes during the same hours are those most apt to contract malaria. *Anopheles* mosquitoes are frequently found in localities where no malaria exists. These are harmless because no person with malaria plasmodia in his blood has come to their region and infected them.

Fumigation. — Efficient fumigation will destroy mosquitoes within buildings. The culicide employed at New Orleans during the yellow fever outbreak in 1905

[1] S. P. James: *Indian Jour. Med. Research*, July, 1914.

was composed of equal quantities of carbolic acid crystals and gum camphor. The carbolic acid was melted by being gently heated, and the camphor then added. The resulting solution was kept in jars. As a fumigant, three ounces of the solution were used for every one thousand cubic feet of room capacity. The solution was placed in a granite-ware or tin basin and heated over a low flame until volatilized. The room was sealed twenty minutes. All insects within the room were killed. A cheaper substitute and one more easily prepared, which is apparently as effective, is one composed of equal quantities of crude, liquid carbolic acid and naphthalene balls.

Naphthalene is an active culicide. In some preliminary experiments the writer obtained promising results upon volatilizing ordinary naphthalene moth balls, 1 gram or 15 naphthalene balls to 1000 cubic feet of air. Mosquitoes and some other insects tested were easily killed by the naphthalene fumes. The naphthalene is volatilized by heating it upon a tin lid over an alcohol flame; the fumes, however, are explosive when concentrated or readily ignite if the lid becomes too hot. Bacot reported [1] obtaining dead or dying mosquitoes in seventeen hours when using naphthalene in the proportion of 1 to 3000. His recommendation of suspending naphthalene in a cloth bag within a well to exclude mosquitoes may be extended to other similar usages. Pyrethrum fumes cannot be depended upon to kill insects when the powder is burnt within a room.

Oil of citronella is one of the best protective liquids to use for rubbing upon the hands and face to keep away mosquitoes. Oil of pennyroyal and oil of tar are also efficacious. An excellent mixture published by Dr. L. O. Howard is:

Oil of citronella	1	ounce
Spirits of camphor	1	"
Oil of cedar	½	"

[1] A. W. Bacot: *British Med. Jour.*, July 4, 1914.

Another effective application is oil of citronella in which is dissolved naphthalene, nearly to saturation. A few drops of this rubbed upon the skin or dropped upon the pillow will dispel mosquitoes for a while. For regions in which the *Stegomyia* are found a more durable fumigant is needed as the yellow fever mosquito begins to bite at daybreak. In such localities a mixture of one ounce of citronella, in which are dissolved two or three naphthalene moth balls, and four ounces of liquid petrolatum may be used.

Screens. — House screens for excluding mosquitoes should be made efficient. Window screens should be placed on the outside of the window and should fit tight. In malarious regions the screen should extend the whole length of the window. The interchangeable screens made of two slipping pieces or with spring ends are unreliable and should not be used as they do not completely fill the window space and in other ways will pass mosquitoes. Copper wire screens are best. If black iron wire is used it should be painted before being put up. Galvanized wire cloth should be painted before the first summer is over. The screens should be repainted at the beginning of each year. Asphaltum is the paint recommended for this purpose. The size of the mesh for mosquito screens should be No. 16 wire, having 16 meshes to the inch. No. 12 is that commonly used and No. 10 is frequently sold, but both are too coarse. Some *Anopheles* will pass through No. 14 mesh wire, therefore wire cloth with 16 meshes to the inch should be used. *Stegomyia* require No. 18 wire.

Screen doors should be made of No. 16 mesh wire and be made to fit in the doorway. They should be braced so as not to sag out of shape. Von Ezdorf recommended a piece of light canvas nailed in the doorway at the top, extending the whole width, and another strip about two inches in width nailed to the bottom of the screen door.

The canvas or muslin is so hung that it completely covers any cracks found above or below the door. All mosquito screens should be kept in good repair.

Cisterns and rain-barrels should be screened with No. 16 mesh wire painted. Barrels and wash tubs which are necessarily kept filled with water to prevent their drying out, should be protected from mosquitoes. Cheesecloth, muslin or cotton cloth or good burlap will serve. A square piece of cloth with a few nails or bolts tied to each corner for weights may be used to drape over the barrel top, the weights making tight joints and keeping the cloth in place. Mosquitoes easily discover any small holes or folds through which they may enter.

Oiling. — Oil is applied to the surface of mosquito-infested pools to prevent the larvæ breathing. It suffocates but does not poison the wrigglers. The oil must form a continuous coating over the water, not leaving any open areas to which the wrigglers could go for air. On quiet water the oil quickly spreads itself over the surface, but less readily where there is much grass. The oil will not remain evenly distributed over the surface of an exposed pond, but becomes blown to one side by the wind, leaving an exposed area along the lee shore. Oiling is more effective if done when there is not a high wind blowing. It should be done after rains, since rains flood pools overflowing the oil onto the land, and after rains more pools are found.

Coal oil or kerosene is the oil used. About one pint of oil is sufficient for a water area of forty feet square, or two tablespoonfuls to a pond four feet in diameter. Coal oil evaporates within a few days and needs renewing in ten days or two weeks. A more permanent oil is made by combining crude oil with kerosene. In cool temperatures 3 parts of kerosene are used with 2 parts of crude oil. In hot weather about 8 parts of kerosene to 10 of crude oil is more effective.

The larvicide used in the Canal Zone was made as follows:[1] 150 gallons of crude carbolic acid was heated in a tank to 212° F., then 150 pounds of powdered or finely broken rosin were added. The temperature was maintained while 30 pounds of caustic soda were added, until a dark emulsion without sediment resulted. The mixture was stirred constantly during the process. The product is ready in a few minutes and yields 3½ barrels. The crude carbolic acid must contain not less than 15 per cent of phenols. This larvicide will kill mosquitoes in a 1 to 1000 emulsion in water in from one to five minutes. It will kill larvæ in half an hour in a 1 to 5000 solution. It, however, loses its larvicidal properties when exposed to air for more than an hour, and is ineffective in sea water and in brackish water. The larvicide was applied by a knapsack spray pump.

Oiling is best done by using the knapsack sprayer, but may be done with a watering pot, a hand spray-pump, or scattered around from an ordinary tin can. A drip-can may be used. The drip-can is an ordinary tin can supported a few inches above the water surface, and from a plugged perforation in the bottom the oil is allowed to drip continuously. The rapidity of dripping is determined experimentally for each locality. The dripping should be sufficient to produce a solid coating of oil where desired, but not so rapid as to yield a thicker layer than is necessary.

Drainage.—By the removal of standing water or by altering the flow to produce a constant movement of the entire surface of a body of water mosquito breeding is lessened. Ditching is done for draining swampy land to exterminate mosquitoes. Ditches should be straight and as short and few as possible. The sides should be smooth, be free of weeds, leaves or sticks, and be shaped to confine the water to a narrow channel of constantly moving surface.

[1] Dr. S. T. Darling: *Am. Jour. Public Health*, Feb., 1912, p. 89.

The bottom of the ditch should be smooth, not permitting the formation of puddles. The sides of the ditches should be straight. At sharp bends where scouring may occur, the banks should be protected by boards or by stone work, but in each case no quiet little nook should be left to harbor wrigglers. The sides should be sloped to prevent caving, in hard clay they may be almost vertical. Where ditches run along the side of a hill the upper side of the ditch must be flatter than the lower side if the groundwater is close to the surface. Where sufficient grade is available a slope of 12 inches or more in 400 feet is desirable.

Subsoil tile drains are more effective and satisfactory than ditches, being more permanent, requiring less attention and affording no opportunity for mosquito breeding.

Salt marsh and other flat land lying but a few inches above the water level can be effectively and economically ditched for drainage. The ditches are dug by a ditching machine or by long bladed spades used by hand. The ditches are 10 inches wide, 24 to 36 inches deep, straight and with smooth sides. They are effectively spaced from 50 to 200 feet apart when parallel. The ditches in salt marsh are regarded as practically permanent, requiring little future attention. Headlee stated[1] that the 60,500 acres of salt marsh ditched in New Jersey was done at an average cost not to exceed $5. Besides conquering the mosquito problem the yield of salt hay, worth $8 per ton, was increased from 0.7 ton yield per acre upon undrained marsh to 26 tons per acre on ditched salt marsh. In the first four years of work in New Jersey 25,000 acres were reclaimed, $1 of expense producing a ditch 50 feet long and permanently draining $\frac{1}{4}$ acre of salt marsh.[2]

The natural enemies of mosquitoes include various species of small fish, the larvæ of dragon flies and perhaps of other insects, and probably certain adult insects, as

[1] T. J. Headlee: *Jour. Economic Entomology*, June, 1914.

[2] Rep. N. J. State Entomologist, John B. Smith.

the so-called "water boatmen." Top minnows, bullhead minnows, killifish, sticklebacks and many other small fish devour mosquito larvæ in great numbers. These fish are used for that purpose, and ponds which form advantageous breeding places for mosquitoes should be stocked with minnows. Goldfish are also very useful for this purpose, very rapidly clearing a pond of its mosquito larvæ. Fountain basins, artificial lily ponds, and other pools used for decorating lawns should be stocked with goldfish. Bats devour mosquitoes in great numbers and should be protected.

FLIES

It is commonly accepted that flies transmit typhoid fever, but since the difficulty of establishing the fact is so great the flies are convicted mainly upon conjecture. The circumstantial evidence in a number of investigations has been very strong. When searching for the source of an outbreak of typhoid, fly transmission should not be recorded as the source of infection until complete epidemiological data are obtained. Flies, however, without much doubt, fill a considerable rôle in the production of sickness. The stable fly, *Stomoxys calcitrans*, has been accused of transmitting diseases, and other dipterous insects have come under suspicion. The common fly, *Musca domestica*, is the fly which becomes the greatest pest. Other species of flies are occasionally found in houses. When the fly emerges from the puparium it is fully developed and does not grow any larger. The minute flies occasionally found around the fruit dish or at the sink are not young house flies but are adults of other species.

Flies do not commonly travel far, since food and breeding places are easily found. In some English experiments by Hindale and Merriman it was shown[1] that flies tend

[1] Edw. Hindale and Gordon Merriman: *Jour. Hygiene*, April, 1914.

to travel against or across the wind and not to go with the wind. They traveled farther during warm and good weather; the greatest distance traveled was 770 yards across open fenland. Forbes in Illinois caught artificially colored flies a quarter of a mile from the point where they were liberated. The study of the flight of insects is important in epidemiological work while tracing the probable source of cases of sickness which may be transmitted by these insects. If a known source of infection is beyond the flying range of flies some other original source or some other means of transmission is then sought.

In studying the flight of flies a number of these are caught alive in wire cages, and are then colored by a distinctive color and liberated at a desirable point. At varying distances, in places frequented by flies, traps or fly paper is set and examined periodically. Sticky fly paper is best adapted for catching the artificially colored flies. It is exposed in places where flies are attracted, in cow stables, house kitchens, at the privy, pigpen, swill barrel, or garbage can. For giving the flies a distinctive color, which would serve for the identification of all members of a certain liberated batch, Hewitt wet the flies with a solution of rosalic acid in ten per cent alcohol. A solution of phenolphthalein or other strong indicator may be used. The fly paper which has been set to catch the marked flies is washed over the surface with a caustic potash or other alkaline solution. Flies previously wet with rosalic acid or phenolphthalein appear a bright red under the alkali. Nuttall shook flies up in a paper bag containing some powdered chalk. The flies may be colored by spraying with analine dyes from an atomizer. Powdered potassium permanganate or a powdered analine, as fuchsin or eosin, may be blown or shaken over them. After catching the flies on sticky fly paper and pouring water over them the colors will become evident and indicate what flies have been caught and in what numbers. Stained

flies are readily counted when caught. By using different colors for the different distributing stations a series of experiments can be carried on at the same time. If it is desired to determine if the flies which appear at a certain place, as a store, frequent a certain manure pile, lime may be scattered over the manure and the caught flies examined for white feet. During the Spanish war, Dr. Walter Reed sprinkled lime in the camp latrines and examined the flies caught at the camp kitchens, the white feet of the flies indicating where they had crawled. Dry fuchsin or other analine stain may be scattered over the manure, and after catching the flies upon sticky fly paper a sprinkling of water will reveal the stained flies. If a certain number of flies are to be liberated in an investigation, they may be placed under a large glass funnel and as they crawl out of the stem they are counted and at once liberated, or caught in a paper bag.

The breeding places of flies may be any warm, damp and soft decomposing vegetable or animal matter not entirely immersed in water. Flies breed in countless places, but chiefly in manure, in decomposing garbage, and in the moist soil around stables. Upon a farm the cow manure is much more responsible for the flies than are the sweepings from the horse stable. The fly larvæ can readily be found in the moist earth which receives the barn drainage, in the cracks between the boards of the flooring and in neglected piles of molding hay. The wet pigpen and chicken yard, the rubbish pile, the open box privy, and the decomposing piles of cut grass or weeds each furnishes its quota. The maggots are found in decomposing fruit and in the earth by the house drain.

To prevent flies breeding upon farms the barnyard, stye, and chicken yard should be kept dry, vegetable matter of any kind should not collect in piles, and chickens should be permitted in the barnyard and cow pasture. Chickens eat fly larvæ. A reliable and practical method for destroy-

ing fly larvæ within manure, without a loss of the manure for fertilizing, has not yet been devised. The Department of Agriculture recommended[1] that a solution of 10 ounces of borax in 2 or 3 gallons of water be sprinkled over the manure, that greater quantities of the borax be not used, and that not over 15 tons of borax-treated manure be spread per acre. In composting manure, the interior of the pile becomes too hot for fly larvæ; all maturing is done near the surface. Those larvæ which hatch in the inner portions of the pile work their way to the bottom where they will find dampness, food, and an agreeable temperature. Levy has devised a trap which will intercept and catch these burrowing maggots. He recommends that the manure be piled upon an iron grating. Below this grating is a metal or concrete container holding water. The maggots worm down through the manure and fall into the water where they drown or may be killed by a poison. The water in the maggot trap should be covered with coal oil, to kill both flies and mosquito larvæ.

Screening is of secondary importance to the prevention of fly breeding. As an adjunct, however, windows and doorways should be screened. As noted under mosquito screening, the screens may readily be made practically permanent with a little care. They should be kept in repair and be of the kind which excludes flies. Since most flies enter houses by the kitchen, tight screen doors and windows are especially needed for the kitchen and dining room. Food should be screened separately, aside from the protection given the kitchen. The screening of public eating houses, as the dining rooms of hotels, boarding houses and restaurants, is a public duty and requires legal provision and enforcement. The screening of grocery stores, dairies and other places where food is exposed for sale is no less important.

Screens should be put up early in the spring when the

[1] Bulletin 118, U. S. Dept. Agriculture, July 14, 1914.

first flies appear, and be kept in place until after the frost has killed all the flies out of doors.

Fly traps are made by tacking wire cloth or netting over light framework, the underneath side being formed as a cone projecting into the interior of the trap. The apex of the cone is left as a small open hole through which the flies crawl. The trap stands on legs which are in length about one-tenth the shortest diameter of the base of the trap. A door may be made in the side or the base may be detachable for removing the flies after being killed by heat or hot water. The traps are placed where flies frequent. They may be baited with molasses and vinegar in a saucer beneath the trap.

Flies avoid strong wind. They may be kept from entering the doorways of restaurants, stores and hotels by using an electric fan just within or above the door to blow a breeze outwardly.

In the home, flies are best caught by sticky fly paper, by baited wire traps or swatted. Poisonous baits, as the arsenical papers, should be prohibited, numerous deaths of children eating them having occurred. Sticky fly paper can be made by coating paper with a mixture of one-half pound of powdered rosin dissolved in one quart of castor oil. Flies may be killed by formaldehyde. Several drops of formaldehyde and one or two drops of laundry bluing are added to a little milk in a saucer holding a piece of bread. The bluing is used as a warning signal for children and others.

FLEAS

The common rat flea, *Pulex Ceratophyllus fasciatus*, is probably the chief carrier of plague to man, other fleas being apparently not well adapted for the needs of the plague bacillus. Its destruction and the prevention of bubonic plague are dependent upon the effective destruction of rats and other small animals which carry the fleas.

The human flea, *Pulex irritans*, is little concerned in the causation of plague, but it may play a rôle in transmitting other diseases, besides being an obnoxious pest.

Epidemics of fleas occasionaly sweep over large areas, appearing in great numbers in many houses. The appearance or stay of these fleas appears to have little, if any, connection with any household pets or rodents. These visitations are apparently analogous to the great plagues of other insects which sweep over large sections, as the locust plagues. The writer has seen two flea plagues covering a large area in the vicinity of Philadelphia. These visitations of fleas would be especially damaging if bubonic plague obtained a foothold within this country.

For ridding a house of fleas Dr. Henry Skinner recommends naphthalene. About five pounds of broken or flaked naphthalene is scattered over the floor of a room, and the room is closed for twenty-four hours. The naphthalene is then swept up and used in the next room. In this way, by clearing one room at a time and by taking care that the live fleas do not escape from an untreated room to a cleared one the fleas may readily be conquered. Woolen blankets make excellent flea traps, the fleas being practically unable to jump from them. Fleas cannot jump from wet surfaces if their legs become wet. A pan, wooden box or canvas flooring holding a water surface at least six feet in diameter is a good trap.

ROACHES

A definite relation between the roach or croton bug, *Ectobia germanica*, and disease has not been established.

Roaches are apt to avoid poisoned food. Pyrethrum insect powder blown into all cracks is very efficacious for killing them. Carbon bisulphide sprayed into the cracks or evaporated in the room in the proportion of 2 pounds to 1000 cubic feet capacity will kill them. They may be trapped by placing in a tumbler or preserve jar

a small amount of vinegar and molasses, inclining the glass at an angle of about 60° and placing something to serve as a bridge to the edge of the glass. The roaches slip in and are unable to crawl out. An effective trap is stated as one composed of two saucers with the edges touching and with means provided for easy access to the tops of the saucers. One saucer contains water, and the other a mixture of one part of plaster of Paris and three or four parts of flour. The roaches visit both saucers and quickly succumb. Roaches may be poisoned by bread or cake kept wet standing in a solution of about five tablespoonfuls of sugar and one dram of sodium arsenite in one pint of water.

The best method of getting rid of roaches and similar vermin is by maintaining cleanliness. All food and garbage should be kept out of the reach of insects. Cracks between boards should be filled and all holes and crevices in the walls filled and repaired. Leaks in the plumbing should be repaired and the boarding kept dry. Roaches probably eat most vegetable food, including rotten wood and molds which form upon damp wood. If the vermin are starved they soon disappear.

BEDBUGS

The *Cimex lectularius*, or bedbug, has been suspected of transmitting typhoid fever and other diseases.

Bedbugs may frequently be killed by blowing pyrethrum insect powder into the cracks they frequent. With iron beds a few drops of alcohol may be poured into the cracks and burnt. A small torch may be passed under iron bed springs. Sulphur burned within the room is very effective. It is used in the proportion of 2 pounds to 1000 cubic feet capacity. It may be burned in a coal hod which rests in a tub of water. A little alcohol poured over the sulphur and lighted will help to ignite it. Formaldehyde fumes will not affect bedbugs. Where wooden

furniture is to be treated, all fires and flames should be removed from the room, and then benzine poured into the cracks of the wood.

RATS

Rats are recognized not only as expensive pests, as destroyers of great quantities of grain and other foodstuffs and of furniture and house fittings, as destructive to fruit trees, poultry and property, but as a distinct menace to health and life. They carry the fleas which transmit the bubonic plague. The obliteration of the rat through federal, state and municipal assistance and by community and private initiative is of great economic and life-saving importance. Any practical measure which will lead to the ultimate elimination of the rat or which will immediately begin his local destruction is worthy of universal consideration and adoption.

The habitat of the rat is any dark hole where he may remain unmolested and from which he may emerge in search of food. The purpose of determining where rats live or into what holes or parts of buildings or structural work they may crawl, is the adoption of means for filling these cavities or making access to them impossible. The enormous size of the local problem of exterminating rats will be appreciated when it is remembered that rats begin breeding when three months old, and that the adult female is reported to bear from three to five litters a year, each litter containing from six to ten or more young.

The chief activity against rats will be the rat-tight construction of the parts of buildings next to the ground. These parts to receive attention are house cellars, barn floors, wharves, railroad and other platforms, and other buildings of similar structure. Cellars should be made rat-proof. The flooring should be cemented and good cement used for the foundation stonework. All cracks between the stones within a foot of the floor should be

carefully cemented. Cheap lime plaster should not be used in any foundations. All holes in the foundation through which drains and service pipes extend should be carefully sealed with cement. The joists should be boarded over or bricked to prevent rats getting up into the walls of the house. Barns and other buildings should be protected. The concrete or smooth masonry foundation of all buildings should extend three feet above the ground surface.

Sewers should be constructed to prevent the entrance and egress of the rats. Where catch-basins are used they should be three feet deep and kept clean and the wall lining cemented perfectly smooth. The street inlets to the sewers should be large and screened with iron rods not over a half inch apart. Long, low and vertical inlet openings are recommended. House connections and laterals to sewers should be so built that rats cannot travel from the house into the sewers. The outfall of the sewers should be protected against the escape of rats. Where partially or wholly above the surface of the water which receives the discharged sewage, the openings should be so built and smoothly cemented that rats cannot climb into the sewer from the shore.

In the prevention of the importation of rats from ships, the boats are fended off four feet from the wharf. Rat guards are placed around all hawsers. These guards consist of pieces of tin, thirty-six inches in diameter with a hole in the center opened by a cut in from the periphery. They completely encircle the rope and prevent any rat walking along it. All gang-planks when not in use are removed or are similarly guarded by sheet tin guards. The vessels are fumigated with coal gas. Carbon monoxide is generated in a Harker apparatus and the coal gas is forced into all parts of the ship, rendering a complete deratization of the vessel. Previous to the use of the coal gas, sulphur dioxide, in 4 per cent

concentration was employed. Five pounds of sulphur burned to 1000 cubic feet of space gives 4.5 per cent gas. The time for exposure is 7 hours.

Neither cats nor dogs can be relied upon to rid a house, barn or ship of rats.

Rats should not only be built out but they should be starved out. Simpson has observed that rats can jump twenty-seven but not thirty-six inches high. Therefore, where rat-proofing cannot be done by metal or concrete, three feet of space should separate the rat from his quest. Grain, vegetables and other articles which become the rat's food should be protected by being kept in metal containers or be kept absolutely out of the reach of the rat, and be so guarded that the rat cannot jump down upon them from an elevated location.

Rats are very wary and are difficult to trap or to poison. Any poisons adopted should be used with great caution for fear of poisoning children, dogs, chickens or other birds. Carbon bisulphide sprayed under pressure into the holes may kill some rats. It may be sprayed in the amount of an ounce to each hole.

GROUND-SQUIRRELS

Along the western coast of the United States ground-squirrels are destroyed because they carry fleas which may become infected with plague bacilli. The ground-squirrels are trapped or are killed by carbon bisulphide. Into each squirrel hole one-half ounce of refined carbon bisulphide is sprayed under pressure. In some cases water may be used for filling the burrow and drowning the rodents.

Poisoned food is also used for killing ground-squirrels. The formula suggested by Mr. Piper is as follows:

Whole barley	20 pounds
Starch paste	1 pint
Strychnine sulphate	1 ounce
Saccharine	1 drachm.

The whole barley should be threshed but retaining the rough husks. It is placed in a large receptacle, as a wash tub. The starch paste is made of about two tablespoonfuls of laundry starch added to a pint of cold water, the lumps broken and the mass thoroughly wet and mixed. It is then heated to boiling, being constantly stirred. Its consistency is that of cream. The strychnine and saccharine are added to the paste and thoroughly mixed. The hot mixture is then mixed with the barley. The poisoned food is used in the winter and is best distributed very early in the morning before sunrise. It is scattered around in small quantities near the mouths of the burrows.

The squirrels are also killed by shooting or trapping.

Rats and ground-squirrels may be killed by forcing into their holes the exhaust gases from an automobile. A piece of garden hose is attached to the exhaust pipe of the car and the other end is thrust into the rat hole, and the engine set in motion.

CHAPTER XII

THE EDUCATIONAL MOVEMENT

The educational movement in public health work forms the basis of sanitary reform. When the public is approached by a system of graded education it understands that public health work actually compensates a community, but that safety is a relative term, the protection to life and health, as to property, being established in proportion to the expenditures made for it. The general public is beginning to realize that its aggregate welfare is very largely under the influence of the activities of the health officer and his returns to the public are made in direct proportion as the community empowers and finances him to act. The big public health improvements and activities actually have a tremendous educational effect, and the people may learn not only the immediate necessity for the changes, but they understand the reasons and are able to apply these theories for other benefits. Through newspaper publicity other communities learn and profit by example.

A few methods devised by various authorities for arousing the public in the educational movement are herewith given.

A Civic League Sanitary Campaign. — In small cities and towns women's civic leagues are very useful in obtaining sanitary improvements in the communities. The ladies of these clean-city clubs can work individually or as committees, but their work should be systematically outlined and districted to prevent needless overlapping. The members of the civic leagues are usually enthusiastic,

but require leadership and instruction. Unless carefully shown what they can do and how they can do it, they are usually unable to see phases of sanitation in their proper perspective and to give them their proper balance. Their efforts unintentionally drift toward economic practices as a solution of the high cost of living, rather than toward means to prevent sickness.

A ladies' sanitary campaign may be inaugurated for either the business or the residential district of a town. The business district campaign is begun by dividing the district into sections or into classes of establishments, to be apportioned to committees of ladies. If the size of the city will permit, it is preferable to have one committee of ladies assigned to the grocery stores, another to bakeries and meat markets, another to laundries, and others to other establishments. A committee having a specific kind of business place to visit can readily be drilled in the particulars they are to consider. When one committee has an entire city section, including all kinds of places to visit, it cannot conveniently be shown what points to observe. Somebody from the health office should be delegated to accompany the ladies on some of their excursions, and the health officer should cooperate in their efforts and work with them in full accord. The inspections by the committees should be made rapidly and upon unannounced days. Reinspections may be made after two weeks or one month, the campaign to be pursued the year round. Every establishment of the various classes of business receiving investigation should be inspected. Scoring may be done and after a class of stores is inspected the names of the proprietors and their scores should be given newspaper publicity. Detailed score cards may be used. There may be adopted a score card designed after the pattern of that used by the Dallas Chamber of Commerce which I would advise detailing and adjusting to specific conditions:

CLEAN STORE SCORE CARD

Name of Store....................Date of Inspection......

Address...

	Per cent	Grade given
Clean sidewalks	20	
Clean windows	10	
Attractive show windows	20	
Clean floors	10	
Attractive arrangement of stock	20	
Freedom from flies	10	
Cleanliness of rear of store	10	
Total	100	

Stores and hotels soon learn that the plan of the civic club inspections results in good advertising and competition. Any noteworthy unsanitary condition is reported to the local health office. A refusal to permit the inspection is not antagonized by the ladies. Since the work is done for educational effect and not as a legal condemnation better cooperation from the merchants may be obtained by publishing, not all the scores, but the names of the stores having scores over 75, under the caption of the Honor Roll for Clean Stores. Printed colored cards may be given the stores to hang in the windows for recognition, blue for first class, red for good.

The inspections and gradings are all made from a practical standpoint, allowance being made for all necessary confusion, disarrangement of goods and some formation of refuse, which are incidental and unavoidable to the business. Since proper receptacles for refuse should be provided and can readily be used without loss of time in stores, there is little excuse for depositing waste products upon the floor or sidewalk. The inspections begin at the gutter and extend entirely to the far side of the rear street, to determine what becomes of the waste from the store.

The business places to be inspected and scored would include groceries, meat and fish markets, oyster houses, bakeries, candy stores, drug stores, ice cream saloons, restaurants, boarding houses, hotels, clothing stores, barber shops, millinery stores, and similar establishments. They may include offices, and not excepting the offices of doctors and dentists. A sanitary inspection by a private civic organization should in no way interfere with or prevent inspections officially being made by the local health department. Unless full public cooperation is first obtained people will resent unofficial inspections.

Public education carried on through cooperation with women's clubs could accomplish practical results if developed along these effective lines. The women of the clubs should realize the need of teaching other women how to care for their children and should grasp the opportunities they have of doing good. The clubs will generally assist, if shown the way and methods. They may be able to support visiting nurses. If not, the club should be formed to operate over a certain district. Each willing member, after receiving the necessary instruction, should visit the different households having children where her visits are apparently needed. She can personally help or she can describe to the mothers of the poor or ignorant families what is needed and can be obtained in that individual home to make it clean, healthful and habitable. She can tell the mothers how to feed and care for the babies, how to guard the older children against many diseases and how to treat their wounds. Physical, mental and moral cleanliness should be taught. She can act as a true foster mother and with much success, even by a single visit. In many homes her visits will be resented, but this should not daunt her energy. Any intelligent and enthusiastic woman can accomplish a great deal in saving lives if given a little instruction by a physician or health officer, being shown what to do and how to do it. If

she discovers any cases of supposed contagious disease she should report them to the proper authorities.

Block Societies. — The women living within each block, or that area bounded by four streets, may be organized as a block society,[1] or their children may be interested to constitute the society. The intention is to thus encourage competition by having each society make its block the cleanest, the most attractive and most sanitary block in town. Unasked visits are not made inside homes, but a general cooperation is sought to maintain cleanliness. Streets, sidewalks, gutters and vacant lots are all kept in good condition; rubbish, tin cans and weeds are removed. Attention is given to mosquito-breeding places on all vacant and private properties and to fly breeding. Vacant ground should be utilized, its greatest utility being as well-kept playgrounds. If not used as parking it should be used as gardens to be cultivated by the children, for vegetables or for flowers. It may at least be kept as public lawn for civic betterment. At unstated intervals a community club may score the various blocks and give publicity to the deserving ones. The scoring is not for the purpose of criticism of properties, but as a means of showing the approximate relative values of different improvements. Those sanitary or esthetic conditions having the highest scores are the most desirable. The property owner who increases his score improves his property.

Clean-Town Contest. — A broader educational plan for developing town sanitation upon an extensive basis is that advanced by the Utah Development League. Towns are classified according to their population that communities of approximately equal size may be compared. The clean-town contest is practically applicable for only small towns. In the Utah contest the population divisions were taken as from five to ten thousand, two to

[1] Suggested by Chamber of Commerce, Dallas, Texas.

five thousand, five hundred to two thousand, and under five hundred population. The inspection and scoring should be done by the same person or according to a carefully detailed system. The scoring is done on the basis of one hundred, covering the following items. I have slightly altered the relative values as used in the Utah contest, believing these percentages to better represent the relative importance of the various items.

SCORE CARD FOR A SMALL TOWN

1.	Control of infectious diseases	15 points
2.	Water supply	15 "
3.	Sewage disposal	15 "
4.	Garbage collection and disposal	10 "
5.	Stables and disposal of manure	5 "
6.	Sanitary marketing of foods	5 "
7.	Sanitation of school houses and public buildings	5 "
8.	General appearance of homes, barns, barnyards	5 "
9.	Condition of streets, alleys and parks	5 "
10.	Condition of vacant lots	5 "
11.	Development of factory or industrial hygiene	5 "
12.	Presence of flies and rats	5 "
13.	Condition of fences	5 "
14.	Playgrounds and parks	5 "

Baby Week. — Public education respecting babies may be effectively accomplished by a baby week entertainment. Afternoon and evening programs would consist of instructive talks by local physicians and evening addresses by well-known speakers. Music and moving pictures on health topics would be included. It may be necessary to add public entertainers or humorous films to collect crowds. Baby examinations are conducted by having recognized specialists examine and score the babies. After full newspaper announcement, babies are registered for examination at stated times. These babies are given complete mental and physical examinations and are measured and scored by the score card of the American Medical Association. Nothing should permit this examination

of babies to degenerate into a baby show or become a contest. The babies are examined for defects and the parents at once instructed in the necessary plans to pursue. A health exhibit should be held in conjunction with baby week.

Teaching School Hygiene. — Children can be educated to hygiene much more effectively than their parents can be redeemed. Education is the drilling or inculcation of habits into the child. The bad habits which children acquire from careless parents, or which they learn from each other, may be counteracted in school if given sufficient and correct attention. In the teaching of hygiene children can be easily and effectively reached. Upon the education and development of the child depend the progress and strength of the nation. The importance of protecting and guarding the children by medical supervision and practical education must be self-evident. The education of school children in matters of clean, proper, healthy living, in hygiene and sanitation, and in the causation and avoidance of disease may be undertaken in the classroom or during hours out of school. It should be a part of the regular school work. It is accomplished by the textbooks, by talks and by exhibits. The adoption of books on hygiene or sanitation for regular text-books is an admirable plan for boards of education. It is much better to teach hygiene than physiology to grade children. In lieu of regular text-books, pamphlet publications issued by certain state departments of health may be used, as has been done with the monthly Health Bulletins of Mississippi, North Carolina, Virginia, New York and other states and some cities.

School exhibits may be devised to treat of general sanitary subjects or of some subject of local importance. An exhibit may be complete in itself or may be an integral part of a large municipal or state exhibit. An exhibit may be permanently placed or may be extended over a circuit of schools. Demonstrations should be given

in conjunction with the exhibits. In other particulars an exhibit will be of practical value when following somewhat the suggestions as detailed under the section on public health exhibits.

School placards, as printed placards posted singly, have marked educational value. These should be placed permanently where they may be read. They may be used as texts for lessons in essay writing. Their import should be explained by the teachers.

Classes of school children may be organized to receive instruction in practical hygiene or clubs may be formed to learn and to become active teachers themselves. Little mothers' clubs are organized among the girls and are given such special instruction and drilling as become of value to young mothers. Since an object of educating people is to induce them to influence others with whom they come in contact, special emphasis is placed upon that opportunity granted these children. These clubs are organized upon the basis of brotherhood and helpfulness, as are the Camp-fire Girls and the Boy Scouts.

Little Mothers' Clubs may be organized among the girl school children and sanitary police among the boys. The girls receive talks from school nurses and the boys from the school doctors or others. The boys' clubs are for preserving the cleanliness and good appearance of the classrooms and school grounds. Both the girls' and the boys' clubs are taught how they may be of great use in the general public health movement.

School Junior Health Officers. — School children may be given practical experience in sanitation by electing or appointing a class health officer. He shall make daily records and serve one week, submitting a written report of data noted after the plan of the report blank herewith suggested. This work would be instructive for the child, helpful for the teacher and of much value to the school physician or local health officer.

School Junior Health Officer's Report of. . ... School, Dist. No............Grade............For week ending.... . .. . . . 191. .

General Conditions

Weather.

	No. pupils present.	Temp. of room; 11 A.M.	Temp. out-doors.	Raining.	Snow depth in ins.	Cloudy.	Fair.
Sunday.							
Monday.							
Tuesday.							
Wednesday.							
Thursday.							
Friday.							
Saturday.							

Contagious diseases.

Absent from school because of diphtheria, chickenpox, measles, mumps, scarlet fever, smallpox, pink eye, typhoid, whooping cough or other diseases.

Name	Address	Disease

Condition of School Room.

Number pupils enrolled? ....
Is public towel used? ....
Is public cup used? ....
How many individual towels? ....
How many individual cups? ....
Are public pencils used? ....
Are slates used? ....
With what are desks dusted? ....
How often? ....
How often is floor swept? ....
When was floor scrubbed? ....
How often are windows washed? ....
Any spitting on floor? ....
What is the heating system? ....
....
How is room ventilated? ....
....
In what direction does light come to desks? ....
What kind of window shades used? . ..
....

Signed

.... Date .... Junior health officer

Sanitation of School Yard.

Describe water supply ....
....
....
How can it become contaminated? ...
....
....
Give condition of playground ....
....
....
Yard free from trash? ....
Any markings on buildings? ....
State kind of sewage system ....
Condition of closets ....
When were they cleaned last? ....
Does odor reach schoolhouse? ....
Condition of floor ....
Condition of seats. ....
Are vaults fly-tight? ....

Report examined and approved

.... Date .... Teacher

.... Date .... Principal

Fly Contests. — In their real effect fly-killing contests are principally educational features. They teach the dangers which may come from flies and how the pests may be destroyed. In conducting fly-killing contests care should be taken that flies are not intentionally bred for the purpose of yielding a large number of supposedly caught flies. Fly contests are best conducted in the early part of the season when flies are few, as then the result upon the total fly population will be most marked. When conducted in midsummer or later it would be of greater advantage if prizes were offered, not for the greatest number of flies caught, but for a list of the greatest number of fly-breeding places destroyed. The list should give the character and location of the breeding places with a note showing how they were destroyed.

Exhibit Trains. — Originated in Louisiana by Dr. Oscar Dowling, exhibit trains have proved a very effective way to teach the gospel of sanitation to the country folk. A train consists of two or more cars, one car to be the living quarters of the demonstrators and the rest to be devoted to exhibit purposes. The exhibit would consist of appropriate and applicable placards in text and illustrations, supplemented by models. The Dowling plan of action may be adopted. Following a regular itinerary, a press agent announces the coming of the train, having some local person post bills in stores, post offices, school houses and on mile posts at the cross-roads. Upon arrival of the train at a village a careful sanitary survey is made of the entire community, the owners of unsanitary conditions are notified how to improve them, appropriate photographs are taken, demonstrations are given all day at the train and a public illustrated lecture is given in the evening. If possible, moving pictures are shown, or else slides made from photographs taken in the same town. The subjects treated in the demonstrations at the trains should include cleanliness, cause and prevention of disease,

school inspection, the care of babies, cooking and care of foods, lighting and ventilation, dairy hygiene, water supplies and sewage disposal, and other subjects of local importance. A reference to the morbidity and mortality rates as recorded by the state statistician will indicate what diseases need special attention at the separate towns visited by the train.

Street Parades. — Designed and inaugurated by Dr. John N. Hurty in Anderson, Ind., in 1914, street parades form a very effective method for arousing the people. They may be devised for some particular object, as to influence voters for an improvement of the water supply or other public need, or may be general in character to cover various community needs. The parades consist of marchers with transparencies or costumes, floats and bands. The school children are enlisted with clubs, civic organizations and large business enterprises. Business houses may devise floats appropriate to the occasion. The municipality should parade the street cleaners and sanitary force in uniform. If the parade is for a general educational effect commercial houses may exhibit floats, provided everything in the parade relates to public health measures and cleanliness. The floats would exhibit such articles as brooms, soap, bath tubs, ash cans, garden hose, garbage cans, fly paper, lawn mowers and rakes, tents, window screens, house paints, whitewash, lye and chloride of lime. In devising the parade members of the committee in charge should visit various stores and factories and select the articles most appropriate for the parade. Those stores and commercial houses situated along the route of the parade should be requested to make appropriate window displays of such commercial articles as pertain to sanitation and cleaning up.

Newspaper Publicity. — The press is recognized as a powerful and most effectual way of reaching the people. Many who cannot be reached by exhibits and public talks

will be reached by the newspapers. The newspapers mold human thought and this opportunity in public health work should not be neglected. The cooperation of the editors should be sought, but they cannot be expected to print all notices they receive. Since newspaper columns are reserved for news, if public health notices are phrased as news, they will be more apt to be printed and read. All notices presented should be upon paper, not oral; they should be brief, pointed, truthful and plain. It is much better to print two short notices than one long discussion. Pictures add much value. Nothing that savors of sensationalism should be tolerated in the notices coming from the health office; the articles should not be designed to frighten, but to convince and to educate. Newspaper articles should be written in newspaper style and not be prolonged or phrased as scientific discussions. In quoting statistics I believe in using whole numbers and in omitting all decimals and fractions where possible, as recommended in the chapter on vital statistics. The name of the writer of newspaper notices should, at present, not be given too wide publicity, especially if the person be a practicing physician. In special instances it becomes necessary to publish the name of the person writing or making the statement, but this should only be done to show authority. I believe it to be advisable to have all newspaper and magazine articles, notices and editorials signed, at least by an initial. This would fix responsibility and authority.

Newspaper publicity is the easiest and cheapest method to use in public health education, since by it the greatest numbers of persons can be reached.

Local publicity is a requirement for the success of any show, exhibit, parade or other public health venture. Probably the kind of publicity which will ensure the greatest returns is that particular variety of publicity or advertising the local community has already been accustomed to expect and to receive. I believe little can be gained by the

distribution of programs at churches or schools, and am unalterably opposed, from esthetic reasons, to the distribution of any bills or tickets upon the street. A flood of newspaper notices is of great value, but posters in windows, in trolley cars, theaters, stores or along the streets usually attract. The interpolation of an amusing feature at the show or meeting, previously widely announced, will be a greater drawing card than excessive publicity of an educational display or address.

The education of the public in health matters can be carried along in channels hitherto almost untouched; in advertisements, in business house publications, in organizations and clubs, in school societies, and be extended more on bill-boards and in windows. Many advertisements are quite unscientific in their assertions, some intentionally so. A little diplomacy can correct many of these and proper requests will convince the manufacturers of the need of changes. As an example, most cans of chloride of lime state that if a portion of the lime is placed in a wash basin under the bed the air will become purified and rid of all disease. The writer found a St. Louis manufacturer cordially anxious to correct all such misstatements when he was shown how his product should be used to be of value. After having his labels revised to agree with scientific knowledge an entire new set of labels was adopted. State authorities could correct other labels and advertisements, to the mutual advantage of the manufacturers and their customers. The little recipe books given out with foods should be reviewed by medical dietitians; the directions printed on canned goods need revision, particularly to warn the people not to keep goods in opened cans. Milk bottles should have molded in raised letters on the side, "Keep on ice," and "Scald after use." Poisonous medicines and other substances should be dispensed or sold in bottles of distinctive shape or design. All these changes are educational, besides being protective.

Many large business houses send daily, weekly or monthly letters or pamphlets to their agents or customers. It is not out of place to ask these houses to include a single line or a few lines of advice on personal hygiene, for they appreciate that health and vigor in their employees mean increased efficiency and increased commercialism. The "Don't Spit" signs displayed in business houses and public places are not alone demands for decency but are efforts for health. Magazine houses should print similar signs to be distributed to their agents to keep the surroundings of the news stands decent, healthy and attractive.

Bill-board posting is a valuable adjunct to health education, but should not acquire any of the objectionable features of the large bill-boards. Such posting should be the establishment of small bulletin boards rather than the decoration of the unsightly large boarded areas. The small bulletin boards should be located at definite places where they may be seen by people who have time to read them, in school yards, parks and playgrounds, on the porch of the country store, in prominent vacant corner lots, in railroad waiting stations and trolley cars.

Public Health Exhibits. — A most effective means of educating the public in health matters is through the display of exhibits. An exhibit may be of some particular subject, as tuberculosis, or may be general in character. Exhibits vary greatly in size, in subject matter and in the manner of display.

The well-planned public exhibit is probably the most effective single method of educating the public upon matters of health, especially when it is accompanied by an effective demonstration. The exhibit should be attractive and locally applicable. No single exhibit can produce the greatest effect attainable for various localities without a rearrangement of the component parts. An exhibit showing specialties, as, for example, housing conditions and dusty trades, should display in prominent places

those sections which are especially applicable in the particular community where the exhibit is shown. If some specific sections, as those dealing with playgrounds, with the dangers from stone cutting, with hospitals or dairies, are not of local concern, they should be relegated to some corner or other unimportant area. This arrangement permits the subjects which are of local importance to be brought to the fore. Before placing the exhibit material the exhibitor should learn what the special community needs or in what particulars it falls short. The subject matter is then arranged according to this basis. The age, class, nationality and customs of the spectators to the exhibit must also be considered. If a section of the exhibit as already made does not appear to be of especial application it should be exhibited nevertheless, if of educational character and if space permits, as someone may profit by it.

In arranging an exhibit the disposition of the material to be shown should correspond to the habits of mankind. As people enter a room they do not begin to realize they are inside, or act accordingly, until they have gone far past the entrance, therefore, any important exhibit near the entrance will not be seen. Just within the entrance the exhibit material should consist of only placards of display wording that may be read at a glance without requiring much study. Where a large room is used for the exhibit space the exits should be located so that they cannot be seen from a distance. When people notice the exits they tend to hurry toward them and will miss much of the exhibit. Where a building with street windows is used to hold the exhibit, the bulk windows showing on the front street should be utilized to contain attractive displays and not for educational purposes. A striking exhibit when used in a window may convince the public of the necessity of their seeing the exhibit within, but a printed argument being thrust upon them as the introduction will have a repelling effect.

That part of a wall which is usually seen is upon the level of the eyes. Therefore, in hanging the placards and illustrations of an exhibit the most important ones should be hung about five feet from the floor. The whole wall ex-

Mild smallpox; never vaccinated.
His son, vaccinated and protected.

SUCH ILLUSTRATIONS SHOWING MARKED CONTRAST ARE CONVINCING

hibit had best occupy a width of only three exhibit cards or approximately be a band of text and illustrations about six feet wide. Placards in sequence should be hung horizontally when the spectators will be obliged to examine them by following left to right. Otherwise, a

sequence of only two or three placards may best be hung vertically, to read downwards. Sets of cards for sequence should be of few cards to the set. Contrasts count. Illustrations, in text or in picture, in pairs to show contrast have a great effect. These contrast the bad with the good, the harmful with the beneficial, the detrimental with the advantageous, the devitalizing with the upbuilding.

The exhibit material should be truthful, exact and convincing. The seriousness of the subject should not be transgressed. The use of frivolous, exaggerated or impossible pictures or text is a practice to be deplored. I am opposed to the adoption of impersonated, gigantized or misshapen animals in public health educational work, believing them to add a levity which is harmful. Pictures mean more than words, and well-made photographs, water colors, sketches or drawings convey more lasting impressions than mere texts. Pictures are perceived by those who cannot read, but, however, should be labeled by short descriptive texts. They should not be confusing, but distinct. Only illustrations which illustrate should be used. Sketches should not be too flowery or show material not germane to the subject treated.

Text cards to be of greatest value in an exhibit had best be of short, trite phrases or contrasts — definite, concrete, practicable and applicable, readable and distinct. Display headings, or the important words or subject printed in larger type, give an added value. A few words on a card are better than many. Black lettering on white or tinted cards is more readable than white letters on a black ground. The flat exhibit material may be of cards, preferably framed, and hung or tacked upon the walls. Large standards of wooden frames enclosing beaver-board may be used, the illustrations and lettering being painted or pasted upon the beaver-board. Exhibits should be portable and made to be easily erected or hung.

In any exhibit the value of attractive design and of decoration by plants should be considered. A pleasing appearance counts much. Color schemes should be maintained for harmonious effect. The color of bunting for background should be selected according to the color of the exhibit material. White exhibit material, as white cards, cots or tents, may be supplemented by white, yellow, buff or brown background. Where foliage or plants are used, white, brown or green colors harmonize. Sage or moss green is preferable to any other green. Red may be used sparingly with green. Blue and purple do not harmonize with greens, browns and yellows. Reds are antagonistic to purples, light blues and yellows under ordinary circumstances. If the room to be used for the exhibit space is dark, decorations or backgrounds in yellows, buffs, tan with red trimmings, or light gray may be used. In sunlit spaces greens, blues or browns may be adopted.

The demonstrator is the most valuable part of an exhibit. The ability to demonstrate effectively is as difficult to find or develop as the ability to design and make effective exhibits. A good exhibit will make a poor showing if not properly displayed and demonstrated. If it is worth displaying it is worth demonstrating. The public cannot in themselves grasp the full meaning or intent of an exhibit shown silently.

The advisability of publicly displaying pathological specimens of human tissues is questionable. Bottled human anatomy is repellant to many and more properly belongs in certain museums, not in public exhibits. The general public is more apt to be disgusted than enlightened. The specimens are viewed more in horror than for instruction. The display of diseased and normal meats is an entirely different matter and a commendable method for teaching butchers and buyers.

EQUIVALENTS IN WEIGHTS AND MEASURES

1 meter	= 39.37013 inches.
1 meter	= 3.281 feet or about 3 feet $3\frac{1}{3}$ inches.
1 square meter	= 10.7639 square feet.
1 liter	= 1.0567 quarts (liquid) or 0.908 quart (dry).
1 liter	= 61.023 cubic inches.
1 foot	= 0.3048 meter.
1 cubic foot	= 0.0283 cubic meter — 7.48 gallons.
1 gallon	= 231 cubic inches — 3.785 liters.
1 gallon	= 0.13368 cubic foot.
1 acre	= 43,560 square feet — 208.71 feet square.
1 gram	= 15.432356 grains.
100 grams	= 3.5274 ounces.
1,000,000 grams	= 2204.6 pounds.

Avoirdupois: 1 pound = 7000 grains; 1 ounce = 437.5 grains.
Troy weight: 1 pound = 5760 grains; 1 ounce = 480 grains.
1 cubic foot of water at 62° F. = 62.355 pounds = 7.4805 gallons.
1 gallon of water at 62° F. = 8.3388 pounds.
1,000,000 cubic feet = 74,805,194 gallons.
1,000,000 gallons = 3785 cubic meters.
1,000,000 gallons = 133,680.4 cubic feet.
Water 1 inch deep per square mile = 2,323,000 cubic feet.
Water 1 inch deep per acre = 3630 cubic feet.
1 second-foot = 7.48 U. S. gallons per second.
1 second-foot of water flowing 24 hours will deliver 2 acre-feet.
2 gallons of water filtered per square foot per minute equals 105,000,000 gallons per acre per day.
3 gallons of water filtered per square foot per minute equals 156,000,000 gallons per acre per day.
1 grain per gallon = 142.857 pounds per million gallons.
1 grain per gallon = 1068.471 pounds per million cubic feet.
5 grains per gallon = 1 pound per 1400 gallons or 187.37 cubic feet.
1 part to 1,000,000 parts = 8.33 pounds to 1,000,000 gallons.
1 part to 1,000,000 parts = 1 pound to 125,000 gallons.
1 part to 1,000,000 parts = 1 pound to 1662.99 cubic feet.
5 pounds of sulphur burned to 1000 cubic feet = 4.5 per cent gas.

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